THE ATMOSPHERE EFFECT:

An Experimental Study of Reasoning

BY
SAUL B. SELLS, PH.D.

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CHAPTER I

I. Introduction

The investigation of reasoning in problem solution presents two clearly defined aspects or categories of description, logical and psychological. The two are not independent, but rather complementary, since neither is sufficient in itself. Logical description is largely concerned with the correctness or incorrectness of the end product or result of thought. Psychological description, while not overlooking the validity of the result, has as its major object: function, the process of arriving at the result. The complete description of an act of thought must include both logical and psychological facts.

The distinction between logical and psychological facts is illustrated by an analogy. A swimmer, attempting to swim in a direct line from A to B, is forced by a cross current on the way to go to C, at some distance from B. A second swimmer, being stronger than the first, is able to overcome the current, and after a considerable detour, arrive at B. A third, more powerful swimmer, is able to negotiate the crossing in almost a straight line.

A logical description of the feats of the three swimmers deals only with their accomplishment. The second and third reached B, and thus were correct. The first did not reach B, and was wrong. Such description is important, even in as simple a case as the present example. Nevertheless it leaves an impression of incompleteness. The first swimmer knew that B was the correct destination, but something prevented him from getting there. If the direction of the current had changed, it might even have facilitated his progress to B. At any rate, the correct end result, B, has under different conditions, different degrees of difficulty or accessibility. Likewise the incorrect end result, not-B. A psychological description of the situation would include the facts relevant to the progress from A to destination. Such a description, to be complete, would obviously need to evaluate the end result as either B or not-B.

The cross current in our analogy may be regarded as a *determiner* of the response to the situation. Other determiners are, perhaps, the specific gravity of the water, body weight, stroke used, temperature, etc. In the psychological investigation of thinking and problem solving, one of the most significant determiners of an individ-

ual's response to a situation is a factor which has been variously termed mental set, Einstellung, attitude, determining tendency, disposition, directive tendency, halo effect, perseveration. The rôle of conscious attitudes (Bewusstseinslagen) in the thought processes was one of the most important findings of the Würzburg School.[1] Selz (22–24) found that the most crucial phenomenological data, which run their course in consciousness along with the more familiar sensory items, turn out to be impalpable awarenesses of relations and directions. His observers were continually aware that for certain items others of a determined sort must be found, and that their thoughts are directed toward these missing terms, but this knowledge was rarely given in the form of sensory ideas. The fact that in reasoning only those related items appear that are in line with the Aufgabe cannot be explained by association, but suggests rather some selective or directive process. Rees and Israel (21) and Siipola (25) have recently demonstrated the establishment and operation of mental sets in problem solving. In a review of experimental studies of thought and reasoning, Pratt (20) speaks of "a selective or directive factor which gives to reasoning and thinking their most fundamental character. This factor still eludes precise description and definition, but the insistence of the phenomena which indicate its operation is very striking."

The experiments to be reported in this study were designed to investigate a particular kind of determiner of response in the solution of problems requiring inferences. The study is related to the general class of concepts mentioned in the preceding paragraph, and may, after careful consideration of the problem, contribute to a better understanding of this "fundamental character" of thought.

II. Definitions[2]

a. *Set:* a temporary condition of the organism which facilitates a certain specific type of activity.

b. *Einstellung:* the set which immediately predisposes the organism toward one type of motor or conscious activity.

Einstellung may be unconscious in contrast with Aufgabe which is conscious, and which may be the cause of the Einstellung.

(cf. Bereitschaft = mental set)

c. *Aufgabe:* a task or purpose offered by the experimenter to the observer, who, if he accepts it, is prepared or set for the experiment.

[1] *Cf.* Boring, E. G., A History of Experimental Psychology (2).

[2] Definitions a to h are taken from Warren, H. C., Dictionary of Psychology (35).

An individual's attitude or mental set toward a task or problem as determined by instructions or other influences.

d. *Disposition:* any organized mental tendency resulting from past experience or from ancestral conditions.

e. *Determining Tendency:* (Ach 1905) that effect of volition by virtue of which the appropriate activity is performed or the appropriate idea is aroused. This term was introduced in the Würzburg School as a consequence of an Aufgabe, and is somewhat more specific than an Einstellung.

f. *Directive Tendency:* (syn. for determining tendency) a set of subjective conditions which serve to guide the course of ideas or other experiences, these conditions in their more specific form being identifiable as a goal idea, but often not being directly experienced by the subject.

A set of organic conditions which, in conjunction with external stimuli, influence the course of behavior. (Applied to thinking and behavior under natural and experimental conditions.)

g. *Halo Effect:* a tendency when one is estimating or rating a person with respect to a certain trait, to be influenced by an estimation of some other trait or by one's general impression of the person.

h. *Perseveration:* the tendency of a feeling, idea, act, or disposition to recur with or without the aid of associative tendencies.

The tendency of any mental formation, once initiated, to remain and run a temporal course.

i. *Atmosphere Effect:* a temporary set of the individual, arising within a situation (*e.g.,* problem) to complete a task with that one of several alternative responses (*e.g.,* an inference or judgment) which is most similar to the general trend or tone of the whole situation (*e.g.,* problem).

III. The Atmosphere Effect: General Description

Definitions a to h, varying widely in extent and reference, are all alike in that they refer to a dynamic behavior tendency toward a certain direction or specific type of response. The phenomena to be reported in the present research may be descriptively characterized as belonging to the same genus as that described by the terms set, Einstellung, attitude, disposition, determining tendency, etc. However, the use of the new term atmosphere effect is convenient, since none of the available, terms, taken in its accepted connotation, is quite adequate. The atmosphere effect is quite similar to set, Einstellung, attitude, disposition, determining tendency, directive tendency, halo effect, or perseveration in different circumstances, but cannot adequately be described by any of these terms without several specific modifications.

The atmosphere effect is a set which arises within the individual and which is derived from and is specific to a particular problem.

The individual is not necessarily aware of this set. The atmosphere effect occurs in problems or situations in which there is a closed series of responses related to a single task. The result of the atmosphere effect is that the individual makes a response (*e.g.*, an inference or judgment) which is most similar in quality to the general trend or tone of the whole situation set up. This is a psychological determiner of an individual's response in a situation. As in the analogy above, it may lead to either a logically correct or incorrect response, depending upon the specific situation. In the following section a number of illustrations of the atmosphere effect are presented.

IV. Illustrations of Atmosphere Effect

a. Pronunciation of words: Experiences analogous to the following one of the writer have been shared by many. "I was reading a French book on the psychology of thought, pronouncing the words silently in French, when I came upon a reference to a study by Marbe. I am acquainted with Marbe's work, and his name is quite familiar to me. I have always pronounced it in the German manner—*Mar-ba.* But on this occasion, as I was reading, I pronounced it *Marb,* and immediately thereupon felt uncertain, as if the name were unfamiliar. Then, upon reflection, I recognized it as *Mar-ba.*" The wrong pronunciation was the result of a set or atmosphere effect of reading the French context.

b. Grammatical errors of number: A heedless speaker or writer often makes the verb agree in number with the general 'atmosphere' of the subject phrase, instead of with the noun which is the formal subject. For instance:

"The laboratory equipment in these situations were in many instances essentially the same as those used before."

"A common background of emotional conflict, repression, and abnormal reactions of a motor, visceral, or perceptual nature, have justified an inherent relationship."

c. Perceptual phenomena (1—Phi phenomenon; 2—Confluxion illusions): 1—In Wertheimer's (37) early experiments on the perception of apparent motion an effect was observed which is an example of 'atmosphere.' This is schematically demonstrated in Figure 1. If a light is flashed at point b in Figure 1-A, and followed after an appropriate interval by a flash of light at point a, there will be perception of movement from b to a. If thereupon, a light is flashed at c, and then, after suitable interval, at a, there will again

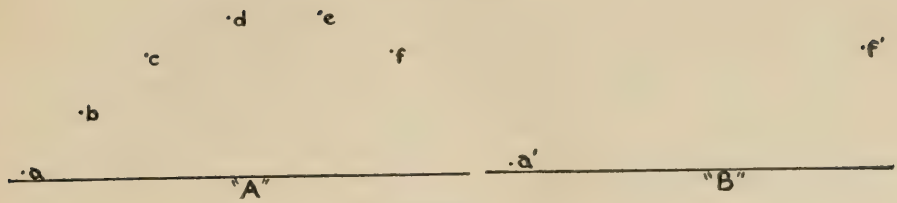

FIGURE 1

be perception of movement from c to a along the circumference of a circle. If the series is continued thus: b–a, c–a, d–a, e–a, f–a, in this order, and observing appropriate temporal intervals, there will always be perceived movement from the remote point to a. On the other hand, if we were to begin immediately at point f′ in Figure 1–B by flashing a light at point f′ and then after a proper interval at point a′, there would be no perceived movement. The perception of movement from f to a in A may be regarded as the result of the atmosphere effect arising in the A situation, whereas in B the failure to perceive movement from f′ to a′ is accompanied by the absence of any atmosphere effect. 2—An analogous type of atmosphere effect is found in the 'confluxion illusions', such as the Müller-Lyer, in which the observer sees one of two equal lines as longer than the other, because the total impression of one part of the figure is bulkier than that of the other part.

d. Halo effect in rating: The halo effect is probably the most widespread and most frequent example of atmosphere effect. The estimates of job applicants by employers, the giving of grades by teachers, indeed even the choosing of friends by most persons is almost always colored by a halo effect. Historically, one of the most interesting examples of halo effect is found in the results of an experiment by Sir Charles Goring (9) 1913, concerning the intellectual significance of a high forehead ("highbrow") or a low forehead ("lowbrow"), in which he found that the warden and prison physician of an English prison rated those prisoners with high foreheads as more intelligent and those with low foreheads as less intelligent.

e. Animal experiments: (The Hamilton Quadruple Choice Experiment) (10). An example taken from the field of animal psychology reveals a type of error quite similar to the atmosphere effect. Hamilton, in a study of the perseverance reactions of primates and rodents (1916) described a typical response of the rat which is relevant to this discussion. Hamilton used his well-known quad-

ruple choice apparatus (Figure 2) with entrance at E and food in one of the four choice compartments equidistant from E. The correct choice on any given trial was determined by the throw of a die, except that no choice could be correct on two consecutive trials. Several types of response were described. In one response, found

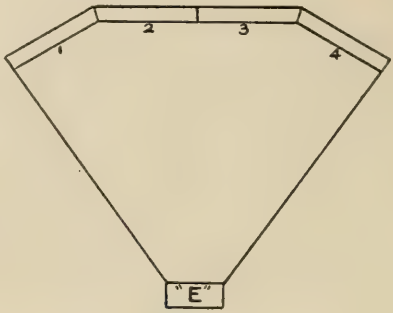

FIGURE 2

only in primates, the animal always attempted each door in systematic order, beginning with door 1, except when door 1 was correct on the previous trial. The lowest type of response, found only in the rat, was of a 'perseverative' type, in which the animal always ran directly to the door which had been correct on the previous trial. Hamilton advanced the hypothesis that this type of behavior is due to perseveration. While not disputing the correctness of this hypothesis, we may nevertheless observe the similarity of the 'perseverative' response to atmosphere effect.

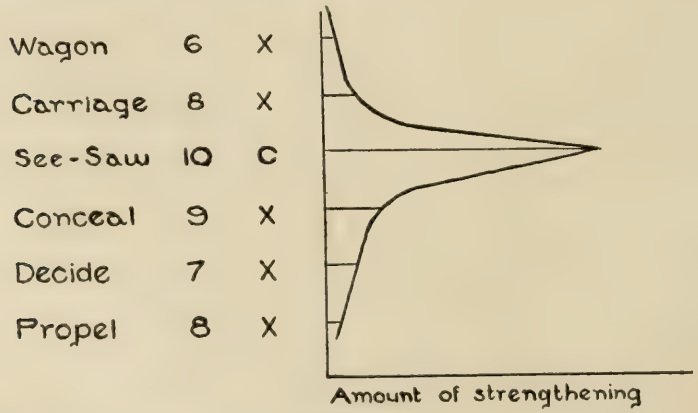

FIGURE 3

X = Wrong (Punishment)
C = Correct (Reward)

f. Thorndike's Principle of the Spread of a Reward: One of the most significant recent findings of Thorndike (33) and his pupils (3, 33) is the spread of the confirming effect of a reward. In a typical serial association experiment, such as the following, in which the subject must learn to connect each word with an appropriate number out of five possibilities (6, 7, 8, 9, 10), it was found that connections nearest the rewarded connection were strengthened, although they were not themselves rewarded.

The curve at the right in Figure 3 shows schematically the effect of the spread. At a more remote distance from a rewarded connection the strengthening value of a punishment or of a neutral effect (neither reward nor punishment) is zero. This phenomenon may be quite adequately described as an example of atmosphere effect in that in the series of responses there is a tendency to repeat the previous response to a stimulus following a situation when it is correct to do this.[3]

g. Global resemblance: In a very important work on the relation of abstract geometry to the sensible world, Nicod (15) has described a type of perceived relation of similarity or resemblance which is based upon psychological rather than logical data. The global resemblance is a perceived relation between objects, based upon a vague, generalized, total resemblance of the wholes, which may function as a psychological determiner of an inference or judgment in a direction either in agreement with or opposed to the correct logical relations.

The foregoing paragraphs have presented several orthodox and well-known psychological phenomena in a new and (in some cases) unorthodox interpretation, as illustrations of atmosphere effect.[4] However, while it may be quite valid to assert that an atmosphere effect is a determiner, and perhaps even an important determiner of each of these phenomena, without further research it would be extravagant to claim more. Other and perhaps more significant factors may be responsible for the occurrence of these responses. Nevertheless, the bond which enables us to assemble in a single category such diverse appearing aspects of behavior as the perception of motion by the adult human under certain conditions and the

[3] The similarity of the spread effect to generalization of the conditioned response suggests further that the atmosphere effect may be related to this phenomenon.

[4] It should be clear that these are not the only examples of atmosphere effect. The present list could be greatly increased. The intent of this section is only to demonstrate the phenomenon, not to catalogue all manifestations of it.

errors of rats performing in a problem situation consists essentially in this dynamic function which we have called atmosphere effect.

V. The Problem: General

Thus far we have presented a general definition and a number of illustrations. We turn now to a more concrete formulation of the problem. The 'atmosphere' hypothesis was first formulated by Woodworth to explain the occurrence of errors in direct conversion of logical propositions.

We have all heard that the converse of a true proposition is not necessarily true. Nevertheless it is very apt to seem true. In studying the protocols of Störring (27–31), Eidens (6), and Wilkins (38), of experiments with syllogistic forms, Professor Woodworth was impressed with the frequency with which the false converse of a simple proposition was accepted as correct, even by educated subjects.

If we use the customary symbols of formal logic, A, E, I, and O, for the four kinds of formal propositions, namely that:

A = Universal affirmative, as in "All a's are b's";
E = Universal negative, as in "No a's are b's";
I = Particular affirmative, as in "Some a's are b's";
O = Particular negative, as in "Some a's are not b's";

we find that even educated subjects are very likely to accept the direct converse of any of these propositions (see Table I), although E and I are the only ones susceptible to simple conversion, while A can only be converted into I, and O cannot be converted at all.

Now why should subjects so readily accept the conversions of A and O? The hypothesis which Woodworth formulated to account

TABLE I

Percents of Subjects Accepting the Direct Converse of Simple Propositions

In the column at the left is the type of proposition; the columns at the right show the type of converse. Where there are no entries there were no problems of that type used. The number of subjects is 90. (Data from Test I, below, only abstract items.)

	Type of Direct Converse			
Proposition	*A*	*E*	*I*	*O*
A	33	.....	86	17
E	.....	86	2	78
I	14	.....	86	41
O	.....	.....	39	38

for this is that *the atmosphere of the converted proposition is the same as that of the original proposition.*

A has an *all-yes* atmosphere.
E has an *all-no* atmosphere.
I has a *some-yes* atmosphere.
O has a *some-no* atmosphere.

When the subject does not grasp the relationship clearly, (or in addition to any relationship which he may perceive), he develops a set or Einstellung or directive tendency toward the converse which is most similar to and thus has the same atmosphere as the premise. The atmosphere effect thus tends to create a sense of validity for the corresponding conclusion.

VI. Statement of the Problem

The problem of the present investigation is to check the validity of the atmosphere hypothesis and to analyze the conditions of the atmosphere effect in reasoning with formal syllogistic problems. The research is subdivided into the following specific tasks:

a—The objective demonstration of the atmosphere effect in reasoning with formal syllogistic problems;

b—The investigation of the influence of intelligence on the atmosphere effect;

c—The investigation of the influence of age on the atmosphere effect;

d—The introspective study of atmosphere effect.

Formal syllogisms were chosen as materials for the investigation for several reasons: 1. Syllogisms, especially those using purely symbolic terms (as in All a's are b's) have some of the advantages possessed by lists of nonsense syllables in memory experiments in their freedom from extraneous associations and from factual truth or falsity. 2. There is a wide variety of classifiable errors in syllogistic material, the errors being readily classified by the types of propositions in premises and conclusions. 3. The atmosphere effect in formal syllogistic reasoning is relatively well defined and measurable.

VII. The Relationship of Logic and Psychology

In many cases of deductive thinking, especially those involving great complexity or subtlety of thought, it is important to verify conclusions by means of some definite criterion of correctness. The formal syllogism is one such criterion. "The primary function is

the same for every form of the syllogism, namely, to point out and make explicit the relation between general and individual notions employed in making transitions of thought, particularly to make clear the ground for all inferences.''[5]

The syllogism does not establish the truth of the original premises. All that it can do is to verify thought processes in making transitions from one to another by inference, provided the premises are true.[6]

While the analysis of syllogistic errors involves to some extent the use of the terminology of logic, the discussion of reasoning within these covers is psychological. The distinction between psychology and logic is brought into sharp relief when we consider the problem of thinking. Formal logic gives principles and rules useful in checking up the 'explicit' results of reasoning, but it ignores the 'implicit' processes of arriving at these results. This is the problem of psychology. Logic is more akin to mathematics than to psychology. It is a rational rather than an empirical science. Its laws are deduced from a few basic axioms and postulates, and not derived from the examination of the actual process of thinking.

The validity of a conclusion in a formal syllogism depends upon the satisfaction of certain criteria which are set forth in the formal rules of the syllogism.[7] These rules or axioms are fundamental in formal or Aristotelian logic:

1. Every syllogism has three and only three terms.
2. Every syllogism contains three and only three propositions.
3. The middle term must be distributed at least once in the premises, and must not be ambiguous.[8]
4. No term must be distributed in the conclusion which was not distributed in the premises.
5. From two negative premises nothing can be inferred.
6. If one premise be negative, the conclusion must be negative. (To prove a negative conclusion one of the premises must be negative.)
7. From two particular premises nothing can be inferred.
8. If one premise be particular, the conclusion must be particular.

---

[5] Miller, I. E., The Psychology of Thinking (14), p. 256.

[6] The fact that the syllogism tests only the results of the reasoning process and not the truth of the premises is made the basis for a specific method of proof in geometry, namely, the method of Reductio ad Absurdum. Here correct reasoning gives a conclusion which is known to be wrong; hence we know that one of the premises is false.

[7] *Cf.* Cohen, M. R., and Nagel, E., An Introduction to Logic and Scientific Method (5).

[8] A term is said to be distributed when it refers to every member of a class.

(To prove a universal conclusion both premises must be universal.)

The violation of any of these rules constitutes a logical fallacy. Thus we have the fallacies of four terms, of undistributed middle term, of illicit process of major and minor terms, of two negative premises, of two particular premises, etc.

Now although these categories are quite valid to the logician in describing the formal nature of the error made, they are of doubtful value in describing the psychological nature of errors in reasoning. The psychologist has a "clinical" interest in syllogisms. It is his task to discover among the numerous logical forms the psychological factors responsible for errors.

VIII. The Atmosphere Hypothesis Formulated to Account for Errors in Formal Syllogistic Reasoning

The first attempt to enlist the atmosphere effect in the explanation of errors in formal syllogistic reasoning was that of Woodworth and Sells (39). This paper was based upon an analysis of the data of Wilkins[9] and the first syllogism test of the author (see chapter 2), and was a preliminary to the present investigation. In this section we shall recapitulate the basic and supplementary hypotheses of atmosphere in syllogistic reasoning.

Beginning with the original discovery of Woodworth, we have the primary hypotheses of atmosphere as follows:

An A proposition has an *all-yes* atmosphere and calls for an A conclusion.
E proposition has an *all-no* atmosphere and calls for an E conclusion.
I proposition has a *some-yes* atmosphere and calls for an I conclusion.
O proposition has a *some-no* atmosphere and calls for an O conclusion.

Woodworth and Sells have supplemented and elaborated the hypothesis in order to cover the syllogism, with its two premises. If they are both of one kind, A, E, I, or O atmosphere clearly calls for a similar conclusion. But if one premise is A or E and the other I or O, the atmosphere is partly universal and partly particular, a blend of all and some, which would certainly be weaker than a straight all and thus would amount to a some; and if one premise is A or I and the other E or O, the atmosphere is partly affirmative

[9] *Ibid.*

and partly negative, which would be weaker than a straight yes and would thus amount to a no.

In detail, the secondary hypotheses of atmosphere are that

a) the presence of a negative proposition in the premises creates a negative atmosphere effect;
b) the presence of a particular proposition in the premises creates a particular atmosphere effect.

The introduction of the secondary hypotheses constitutes in effect a departure from the original definition of atmosphere effect. The atmosphere effect was defined (page 7) as a set to complete a task with that one of several alternative responses which is *most similar* to the general trend or tone of the whole problem. It seems arbitrary then, to say the least, to resolve the "positive-negative" and "particular-universal" cases by stating that the tone of the whole problem in the former case is *negative* and in the latter case, *particular*. However, this procedure is neither arbitrary nor a posteriori. It rests upon the same foundation as the rules for the validity of the syllogism which state

a) if one premise be negative, the conclusion must be negative; and
b) if one premise be particular, the conclusion must be particular.

These rules are axiomatic and cannot be justified, except empirically. Nevertheless it seems that their application to the atmosphere effect is more general, since the atmosphere effect concerns the acceptance of invalid as well as valid conclusions, and therefore that in spite of a longer history, their rôle in formal logic is a special case. In this connection it might be pointed out that errors due to atmosphere effect are pseudo-logical, corresponding to a partially correct *general* determination of the conclusion. The application of formal criteria or "seeing the correct relations" would be a *specific* determination.

With the aid of the secondary hypotheses, then, we should expect the effect of atmosphere upon the acceptance of conclusions to be as follows:

with premises AA, atmosphere effect calls for an A, or weaker I conclusion;[10]

[10] Universal atmosphere may include the cognate subordinate particular under certain conditions (see footnote on page 36, below). If A is true (all x's are y's) then clearly I (some x's are y's) is true; similarly for E and O. But the converse of this proposition, that particular atmosphere may include the superordinate universal, is of course false.

with premises AE, EA, or EE, it calls for an E, or weaker O conclusion;
with premises AI, IA, or II, it calls for an I conclusion;
with premises AO, OA, IE, EI, EO, OE, IO, OI, or OO, it calls for an O conclusion.

The authors postulated two additional determiners which they considered significant as operating towards the acceptance of invalid conclusions in a syllogism test. These are, the ambiguity of the word *some,* which is used in a distributive sense in logic (at least some) and very often in a partitive sense in ordinary speech (only some); and the factor of 'caution' or 'wariness', favoring the acceptance of weak and guarded rather than of strong conclusions. The rôle of each of these is considered in the discussion of the experiments, below.

CHAPTER II

Preliminary Investigation

A. *Standardization of Materials*

The experiments reported under the title of preliminary investigation are concerned with the standardization of the syllogisms preparatory to the main experiments. In this section the relations of different material forms of statement (abstract and concrete) of the syllogism, to each other and to intelligence and age are treated. The results are summarized and interpreted from the point of view of their methodological contribution to the main experiments.

I. Method

The preliminary work was done at Teachers College, Columbia University, where Syllogism Test I was administered to a group of ninety adults regularly employed as subjects on an adult learning C.W.S. project, conducted by Dr. I. Lorge. These adults were of both sexes, ranging in age from twenty to seventy, and ranging in intellect from CAVD three hundred sixty-nine to CAVD four hundred forty (on Army Alpha the range was from thirty-eight to two hundred seven).

The original syllogism test consisted of three hundred items representing one hundred fifty different logical forms, each of which was stated in both abstract (symbolic) and concrete (verbal) form, as in the following example:

abstract item of the form AAA (first figure)	
80) If all x's are y's; and if all z's are x's; then all z's are y's.	80) AT PT U PF AF
concrete item of the form AAA (first figure)	
2) If all members of the senior class are good students; and if all members of the History Club are seniors; then all members of the History Club are good students.	2) AT PT U PF AF

Of the one hundred fifty forms, thirty-five were valid and the remaining one hundred fifteen invalid. These one hundred fifteen invalid forms represent every possible combination of propositions and figures of the syllogism for each of nine formal, logical fallacies, the fallacies of Two Particular Premises, Undistributed Middle Term, Illicit Process of Major Term, Negative Conclusion from a Positive Premise, Illicit Process of Minor Term, Illicit Simple Con-

version, Two Negative Premises, Positive Conclusion from a Negative Premise, and Universal Conclusion from a Particular Premise, arranged so that any given item contains only a single fallacy.[11] Each item in the test consisted of two premises and a conclusion, or, in a few cases, a single premise and a conclusion deduced therefrom. The items were arranged in a random order with respect to difficulty, and the abstract and concrete items were rotated out in the following sequence: C C A C A C A C A A C A C A. The entire test was in omnibus form; it was mimeographed and combined into two booklets of one hundred fifty items each. A cover-page containing directions accompanied each booklet.

COVER PAGE: DIRECTIONS

Name ..... Date .....

You are to read paragraphs, each of which ends in a conclusion which is supposed to follow from the preceding statements in the paragraph. Your problem is to decide whether the conclusion does follow. The question is not whether the conclusion is true or false in itself, but whether it follows from statements preceding it.

Example: If all the members of the club are gentlemen; and if John Jones is a member of the club; then John Jones is a gentleman.

In the above example the conclusion that John Jones is a gentleman does follow from the preceding statements. Sometimes other conclusions may be truer or better than that given. You are, however, only to decide about the conclusion stated.

After each statement and its conclusion you will find a line with the letters AT PT U PF AF.

AT means absolutely true.
PT means probably true.
U means uncertain.
PF means probably false.
AF means absolutely false.

If you think that the conclusion is absolutely true on the basis of the statements, put a circle around the letters AT. If you think that the conclusion is probably true, put a circle around the letters PT. If the conclusion is neither true nor false from the statements on which it is based, put a circle around U. If the conclusion is absolutely false from the statements on which it is based, put a circle around the letters AF. If the conclusion is probably false from the statements on which it is based, put a circle around the letters PF.

You will come across statements of the type

All x's are y's.

This means that every member of the class called x is also a member of the class called y. For instance, the statement

All men are mammals

means that each and every member of the class called men is also a member of the class called mammals.

Answer every question with care. Do not skip any. Work as rapidly as you can without making mistakes.

DO NOT TURN THIS PAGE OVER UNTIL THE SIGNAL IS GIVEN.

---

[11] The fallacies of Two Particular Premises and Two Negative Premises are exceptions.

The limitation of a single fallacy to any given item, although it greatly restricts the number of possible forms, is necessary for any valid comparison of fallacies. This limitation was not observed by Wilkins.

The two parts of the syllogism test were administered on two successive Friday mornings (February, 1934) as part of the regular experimental routine of the project. The subjects were given three and one half hours for each session, which was ample time for all to finish.

The multiple choice type of response was used to obtain greater reliability of judgments and to eliminate guessing. For purposes of scoring, however, the two *logical* categories of response were observed by combining AT and PT to form the True category and U, PF, and AF to form the False category. The score was number right. Scores were computed for each part separately for abstract and concrete items. These and other relevant group data are reported in Table II. None of the subjects used in this experiment had any previous training in logic.

TABLE II

THE MEAN AND S.D. AGE, INTELLIGENCE (CAVD AND SPEARMAN) AND SYLLOGISM TEST SCORES. THE NUMBER OF CASES IS 90

Variable	*Mean*	*S.D.*
Age (months)	422.94	169.16
CAVD (aver. 5 forms)	411.04	15.40
Spearman Vis. Per. Form I	296.65	96.50
Syllogism (total score)	197.01	39.30
(Part I)	98.19	18.77
(Part II)	98.83	21.88
Syllogism (abstract I)	44.28	10.25
(abstract II)	46.00	11.67
(abstract total)	90.28	20.50
Syllogism (concrete I)	53.96	10.24
(concrete II)	52.64	11.19
(concrete total)	106.74	20.73

II. TEST RESULTS

From Table II it is clear that the two parts of the syllogism test are equivalent. The product-moment correlation[12] of Part I with Part II is .870. When corrected for the complete length of the test by the Spearman-Brown formula[13] this gives the reliability of the

[12] All correlations reported in this study, unless otherwise specifically mentioned, were computed by the product-moment method. *Cf.* Garrett, H. E., Statistics in Psychology and Education (8).

[13] The formula as used here for two variables is $r_{pred.} = \frac{2r}{1+r}$.

syllogism test as .931. The intercorrelations of the abstract and concrete part scores indicate that the concrete items have a higher reliability than the abstract items (see Table III). The correlation of abstract I with abstract II is .748 and that of concrete I with concrete II is .844. By the Spearman-Brown formula the reliability of the total abstract scores is .856 and of the total concrete, .915. It will be shown below that the concrete scores yield higher correlations in general than the abstract.

TABLE III

THE INTERCORRELATIONS OF ABSTRACT AND CONCRETE PART SCORES. THE NUMBER OF CASES IS 90

	Con. I	*Abs. II*	*Con. II*
Abs. I	.679	.748	.662
	Con. I	.778	.844
		Abs. II	.805

III. THE RELATIONSHIP OF ABSTRACT AND CONCRETE SYLLOGISM SCORES

Does a syllogism of a given formal structure change in character as a problem when changed from abstract, symbolic to concrete, verbal statement? Logically, the material expression of a statement is irrelevant to its formal structure, but phenomenally it may be very importantly related to it. Verbal material has the advantage of being more familiar and meaningful and of presenting fallacies in a more glaring form. Symbolic material, on the other hand, is terse and concise, is free from extraneous associations and from factual truth or falsity. The problem is studied by a statistical comparison of abstract and concrete data.

Wilkins found that "ability to do formal syllogistic reasoning is much affected by a change in the material reasoned about." (page 77.) Her results show that abstract items are in general more difficult than concrete items, although there are several important exceptions to this generalization. "Most items increase in difficulty as the material is changed from familiar to symbolic, but a few items representing very common fallacies are much less difficult in symbolic material than in familiar." Wilkins considers this due to the fact of bad habits of reasoning in the familiar situation which do not function when the material is unfamiliar or symbolic.

The ratio of the mean abstract to the mean concrete score (A/C) as computed from Wilkins' data is 86 percent and from our data 84 percent. Otherwise stated, this means that abstract syllogisms are on the average 15 percent more difficult than concrete syllogisms. This comparison may be made directly, since there is a high positive correlation between abstract and concrete scores. This correlation was found to be .70 by Wilkins and is .817 in the present study.

The average difference in difficulty between abstract and concrete syllogisms remains the same (15 percent circa) when we turn from comparison of scores to comparison of items; but the shift in difficulty is seen to be neither consistent nor complete. The difficulty of each item was determined by tabulating the number of subjects accepting an incorrect conclusion from the premises. The items were then grouped into the ten formal categories of the test and the Mean and S.D. of the difficulty values of each category computed. This was done separately for abstract and concrete items and for the two combined. Table IV shows the comparison of the means and S.D.'s of the number of subjects accepting incorrect conclusions of abstract and concrete syllogisms for nine formal fallacies and valid conclusions. The number of subjects is ninety. The abstract items are more difficult than the concrete in every category except one, the fallacy of Negative Conclusion from Positive Premises, in which, however, the difference is not significant. Of the remaining mean differences, five, in the fallacies of Illicit Process of Major Term, Illicit Process of Minor Term, Two Negative Premises, Universal Conclusion from a Particular Premise, and Valid Conclusions, are statistically significant. The fallacies of Two Particular Premises, Illicit Conversion, and Positive Conclusion from a Negative Premise have a tendency to increase in difficulty when changed from abstract to concrete statement.

The wide variety of language forms in concrete syllogisms, noted by Burt (4), as contrasted with the homogeneous symbolic statement in abstract syllogisms is seen in the comparison of the standard deviations of the difficulty values of each category. With one exception, that of category VI, Illicit Simple Conversions, the variability of the concrete material is greater than that of the abstract. Although only three of the differences are statistically reliable, the critical ratio of the differences is above two in seven out of the ten cases, and in the comparison of the total number of abstract and concrete items, the difference is 10.21 times the standard error of the

TABLE IV

COMPARISON OF MEAN AND S.D. FREQUENCIES ACCEPTING INCORRECT CONCLUSIONS OF ABSTRACT AND CONCRETE SYLLOGISMS. THE RESULTS ARE GROUPED INTO NINE FORMAL FALLACIES AND VALID CONCLUSIONS. THE NUMBER OF SUBJECTS IS 90

Category	*no. items*	*Mean A*	*Mean C*	*Diff.*	*D/SDd*	*S.D. A*	*S.D. C*	*Diff.*	*D/SDd*
I. 2 partics.	16	54.50	51.81	2.69	.82	6.60	17.95	−11.35	4.89
II. undis. mid.	8	61.00	54.25	6.75	1.52	6.67	12.37	− 5.70	2.88
III. illic. maj.	20	53.15	42.15	11.00	4.93	7.04	14.86	− 7.82	4.95
IV. neg fr pos	4	23.25	29.25	−6.00	1.37	3.56	11.43	− 7.87	2.54
V. illic. min.	6	50.51	20.50	30.01	16.31	2.78	6.48	− 3.70	2.85
VI. illic. conv.	7	33.30	26.29	7.01	1.91	16.82	14.08	2.74	1.06
VII. valid concl.	30	20.95	8.52	12.43	21.81	4.64	5.25	− .61	1.56
VIII. 2 negs	14	39.56	31.34	8.22	4.15	6.24	12.59	− 6.35	4.02
IX. pos fr neg	14	23.35	22.99	.36	.13	13.61	17.46	− 3.85	2.02
X. univ fr partic.	24	20.98	14.72	6.26	6.02	7.76	8.81	− 1.05	1.42
Total	143	35.38	27.27	8.11	13.75	7.35	11.58	− 4.23	10.21

difference, Table IV. The wide range of difficulty in the verbal material is probably responsible for the overlapping in difficulty of the mean scores of the abstract and concrete items.

IV. RELATION TO INTELLIGENCE

The historical conception of reasoning as one of the so-called "higher processes" of the mind raises the interesting question of how far the ability to reason, as reflected by the solution of syllogisms, is dependent upon intelligence, as measured by a standard test of intelligence. Several writers report fairly high correlations between various syllogism and intelligence tests. Wilkins, with a group of 81 Columbia College undergraduates, obtained a correlation of .578 between scores on her syllogism test and the Thorndike College Entrance Examination. Burt reported the correlation of scores on his reasoning test with a group of eleven-year olds as .81 ± .02. Burt regards this as demonstrably the best single intelligence test. It distributes the children of a given chronological age more widely than the Binet, giving the brighter children of that age a higher mental age than the Binet does, and the duller children of that age a lower mental age. Dr. L. W. Max and Mr. S. Roslow, at New York University, found that a syllogism test predicted scholastic success better than the regular entrance examination.[14]

The magnitude of the correlation is undoubtedly a function of the subjects used, the form of the syllogism test, the form of the in-

[14] Private communication to the author.

telligence test, the amount of time given to the subjects on each test, and the methods of scoring. In the present study, the correlation between total scores on the syllogism test and the I.E.R. Intelligence Scale CAVD is .711. In order to determine more adequately the relation between intelligence and ability to solve syllogisms, the abstract and concrete scores on the syllogism test were correlated with the I.E.R. Intelligence Scale CAVD[15] and the Spearman Visual Perception Test, Form I. The CAVD is one of the most comprehensive scales for adults. The measures used in the present study are the average of the scores on five equivalent forms, representing a minimum of twenty-five hours of testing, and have a reliability of .977.[16] The Visual Perception Test, which is a test of "the eduction of relations", contains spatial relations problems. It was used in this investigation as an abstract test of 'intelligence.' The intercorrelations of the abstract, concrete, and intelligence scores and the first and second order partial correlations[17] are shown in Table V.

TABLE V

THE INTERCORRELATIONS OF TOTAL ABSTRACT, TOTAL CONCRETE, CAVD, AND SPEARMAN VISUAL PERCEPTION–I. SCORES AND ALL FIRST AND SECOND ORDER PARTIAL CORRELATIONS. THE NUMBER OF SUBJECTS IS 90

Variables:						
X_1 Total Abstract	$r12$	.817	$r12.3$	.674	$r12.34$	.516
X_2 Total Concrete	13	.633	12.4	.779	13.24	.196
X_3 CAVD	14	.406	13.2	.133	14.23	–.185
X_4 Spearman	23	.709	13.4	.531	23.14	.257
	24	.565	14.2	–.116	24.13	.282
	34	.630	14.3	.012	34.12	.417
			23.1	.429		
			23.4	.550		
			24.1	.442		
			24.3	.216		
			34.1	.527		
			34.2	.395		

Abstract and concrete syllogism scores correlated .633 and .709 respectively with the CAVD and .406 and .565 respectively with the Spearman test. However, although both show a high degree of relationship with intelligence, the correlation between the two syllogism scores does not drop considerably when the effect of the intelligence tests is statistically held constant. r_{12} is .817 and $r_{12.34}$ is .516

[15] *Cf.* Thorndike, E. L., *et al.* The Measurement of Intelligence (32).
[16] *Cf.* Thorndike, E. L., Woodyard, E., and Lorge, I. (34).
[17] For a discussion of partial correlation see Garrett, H. E., *ibid.*

(Table V). This result was also obtained by Wilkins, who reports a correlation of .70 between abstract and concrete syllogism scores, which becomes .548 when intelligence is partialled out. Thus there is a high degree of relationship between behavior in solving abstract and concrete syllogisms which is independent of intelligence. Similarly, the correlation between the two intelligence measures, .630, becomes .417 when abstract and concrete scores are partialled out. The results of these second order partial correlations may be interpreted as indicating two separate ability factors, possibly a reasoning factor and an intelligence factor. Further research and analysis of this problem are necessary to verify the existence and determine the probable identity of these factors.

The higher correlation of the concrete syllogism scores with the intelligence scores is a function of the verbal character which they possess in common. This is clearly shown in the following table:

TABLE VI

VARIABLES: 1—ABSTRACT, 2—CONCRETE, 3—CAVD, N = 90

r_{23}	.709	$r_{23.1}$	.429	D/SDd	2.14
r_{13}	.633	$r_{13.2}$	.133	D/SDd	3.91
D/SDd	.826	D/SDd	2.07		

The correlation of the concrete scores with the CAVD (r_{23}) does not change to a statistically significant extent when abstract scores are partialled out ($r_{23.1}$). The difference is 2.14 times the standard error of the difference, where a ratio of 3.00 would indicate significance. The correlation of abstract with intelligence (r_{13}) on the other hand, changes significantly when the effect of concrete scores is held constant ($r_{13.2}$). The difference ratio in this case is 3.91. Thus the correlation of the abstract with intelligence is demonstrated to be spuriously high when the effect of the verbal factor is controlled. This result provides experimental support for Spearman's (26) statement that "the formal logic of syllogisms, when stripped of accessories and thus reduced to, one might think, the very quintessence of 'intellect', in point of fact exhibits not a perfect, but rather a poor correlation with intelligence as measured in any other way." (page 99).

V. RELATION TO AGE

The relationship of performance in solving syllogisms to age has not yet been adequately determined. Correlations are available at

several age levels, but a comprehensive genetic study of this problem is yet to be worked out. Piaget (18, 19) and Burt[18] both place the beginning of logical or deductive thinking at about seven years. It is at this period that Piaget believes the child's "logic" undergoes a transition from an intuitive, egocentric phase to a deductive, rationalized, socialized phase. Burt found that children down to the seven-year level have full ability to detect logical fallacies.

Burt's comparison of test items that were solved by younger children with those not solved until later affords some indication of the relation with age at this level. As far as strict logic goes, even the seven-year-old child has full ability to reason. When the difficulties were analyzed in terms of the fallacies involved, it was clear that age had little, if any, weight in making some items more difficult than others. On the whole, Burt concluded that "if put in a sufficiently glaring form, nearly every fallacy can be detected and avoided by children of seven; if sufficiently disguised, each will entrap even children of fourteen. The formal character of the fallacy has thus only a small influence on the age at which it can be perceived."

The relationship of the syllogism test scores with age was studied by correlation. The correlations indicate that age is a factor only slightly related to success on the syllogism test under the conditions of the present experiment.[19] The correlation of total syllogism test scores with age is – .196. Parts I and II correlate – .166 and – .123 respectively with age, while the correlation of age with CAVD is – .304. The correlation of the total syllogism test score with CAVD changes from .711 to .698 when age is partialled out; and the correlation of Part I of the syllogism test with Part II changes from .870 to .869 when age is held constant.

These results may only with the greatest caution be generalized beyond the present experiment, since both the syllogism test and the intelligence test CAVD were administered as power tests,

[18] *Ibid.*

[19] "The measurement of the relationship of age to ability is largely dependent upon the manner in which ability and age are defined. Age is generally defined as chronological age (and whatever it may involve in terms of physiology, education, and experience). Ability is defined in two ways (1) The level of difficulty of a task or series of tasks that a person can do successfully, or (2) the number of tasks of equal difficulty that a person can complete successfully in a unit time. Regardless of definition, ability is measured usually by a series of tasks which are of varying difficulty, and which tasks are to be attempted in a unit time. The ability as measured is an undifferentiated mixture of power and speed; power representing the sheer ability to complete tasks successfully, and speed being a measure of the number of tasks that can be completed in a unit time." (Lorge, I., (11)).

with no emphasis at all on speed. It is well known that speed conditions impose a heavy penalty on the performances of older adults.[20] Hence it is not improbable that had speed conditions been enforced, speed, as a function of age, would have introduced a differential between the scores of old and young subjects.

VI. Summary

1. The correlation of Part I with Part II of the syllogism test is .870. The reliability of the total syllogism test is .931.

2. There is a high degree of relationship between abstract and concrete syllogism scores. The correlation is .817.

3. The abstract items are on the average about 15 percent more difficult than concrete items of the same formal structure. The shift in difficulty from abstract to concrete is, however, neither consistent nor complete.

4. The variability in difficulty of the concrete syllogisms is considerably greater than that of the abstract. This fact is reflected in the wide variety of verbal forms in the concrete as contrasted with the homogeneous symbolic statement of the abstract syllogism, and is considered by the writer to be at least in part responsible for the overlap in difficulty of the abstract and concrete.

5. Both abstract and concrete scores show a high degree of relationship with intelligence. Analysis by partial correlation suggests that there is a high degree of communality between behavior in solving abstract and concrete syllogisms which is independent of intelligence; and conversely, that there is a similar relationship between scores on two intelligence tests which is independent of achievement on the syllogism test.

6. Because of their verbal character, the concrete syllogisms have a higher correlation with the intelligence test than do the abstract. The correlation of the abstract with intelligence is demonstrated to be spuriously high when the effect of the verbal (concrete) material is held constant by partial correlation.

7. Under the conditions of the present investigation, age is demonstrated to have no differential effect upon performance on the syllogism test. The effect of previous experience was experimentally controlled; none of the subjects had any previous training in logic.

VII. Conclusion

Because of the results obtained in the preliminary investigation, it was decided to use only abstract syllogisms, "stripped of acces-

[20] *Cf.* Lorge, I., *op. cit.* and Miles, W. R. (13).

sories and thus reduced to the very quintessence of 'intellect' '' in the main experiments in the demonstration and analysis of the atmosphere effect in syllogistic reasoning (Chapter III).

The relationships of abstract and concrete syllogisms to each other and to intelligence are such that no serious sacrifice is made by limiting the research to abstract items only. The correlation between abstract and concrete is high, and both have a high correlation with intelligence. On the other hand, the variability in difficulty of the abstract items in any formal category was shown to be considerably less than that of the concrete, and, as we have indicated above, the abstract syllogisms represent what might be called "purer" reasoning problems than the concrete.

B. *Preliminary Evidence for the Atmosphere Effect*

Woodworth and Sells (39) obtained preliminary evidence for the atmosphere effect in an analysis of the data of the first syllogism test[21] and the data of Wilkins, using only abstract syllogisms.[22] The results of this analysis are shown in Tables VII and VIII.[23]

"The question answered by Tables VII and VIII is this: Given two premises of the types shown in the left-hand column, and a suggested conclusion of the type shown at the top of a column, what percent of the subjects accept the conclusion as valid, when, logically, it is invalid? Each entry shows the responses of the 81–90

TABLES SHOWING THE EFFECT OF ATMOSPHERE ON ACCEPTANCE OF INVALID CONCLUSIONS*

Entries indicate average percent accepting each type of false conclusion from given premises. Blanks mean that corresponding types were not tried in the experiments.

TABLE VII. (N = 81)

Premises	*Types of Invalid Conclusion*			
	A	*E*	*I*	*O*
AA	36		33	11
AE	4	45	4	34
EE	3	21		13
AI	6		62	39
II			51	29
AO			33	47
EI		23	8	44
OO			18	32

[21] See preceding section.

[22] Concrete data were not used because of the greater variability of the verbal material, as shown in Table IV, page 23.

[23] Reprinted from the Journal of Experimental Psychology, 18, 4, 1935.

TABLE VIII. (N = 90)

Premises	Types of Invalid Conclusion			
	A	*E*	*I*	*O*
AA	**51**		**66**	27
AE	8	**51**	19	**54**
EA		**56**		**59**
EE		**41**		**37**
AI	**18**		**66**	
IA	**21**		**70**	
II			**68**	
AO		**18**	**41**	**71**
OA		**21**	**43**	**74**
EI		**31**		**58**
IE		**32**		**59**
IO				**60**
OI				**63**
EO				**53**
OE				**49**
OO				**54**

* Reprinted from the Journal of Experimental Psychology.

subjects to one or more problems; but, where there are blanks in the tables, no problems of the corresponding type were presented.

The bold-faced numbers in the tables show the percent accepting invalid conclusions which are favored by 'atmosphere'; and it will be seen that these percents are always substantial, and larger, with few exceptions, than the percents accepting invalid conclusions not favored by atmosphere. The exceptions and indeed nearly all acceptances not accounted for by atmosphere, can be brought under the other two hypotheses of 'caution' and of the ambiguity of *some*. For many subjects, "Some are" implies "Some are not" and vice versa.

"Caution would lead to the acceptance of a particular conclusion when atmosphere favors the corresponding universal. Thus, with the premises AA, we find fully as many subjects accepting the I as the A conclusion; and similarly when atmosphere calls for an E conclusion, we find large percents accepting the O conclusion as well. There is, however, excellent logical ground for such acceptances, once 'atmosphere' is recognized; for an A proposition logically implies its subordinate I, and E its subordinate O. Whenever a subject would have accepted an A conclusion, he should be willing to accept an I also. (He would not do so, of course, if and when he took *some* to mean *not all*). Thus nearly all the acceptances not referable to mere atmosphere can be explained by atmosphere plus a little

logic, or by atmosphere weakened by caution, or by the ambiguity of *some*." [24]

Although the data presented by Woodworth and Sells support the atmosphere hypothesis in general, the authors correctly concluded that this evidence falls short of what would be demanded for a complete demonstration. There are many gaps in Tables VII and VIII which should be filled in. These gaps represent types of syllogisms which, while they are usually considered too absurd to deserve a trial, should nevertheless be used, perhaps for that very reason. In addition, the ambiguous effect of the word *some* should be controlled by instructing the subjects in its 'proper' logical meaning. In the main experiments, reported in the subsequent pages, both of these conditions were observed. The procedure and analysis of the results in these experiments were similar to those of Woodworth and Sells.

[24] Woodworth and Sells, *ibid.*, page 456.

CHAPTER III

Main Atmosphere Experiments

I. Procedure

In the following experiments, a new set of syllogisms, Test II, improved according to suggestions based upon the preliminary investigation, was used. Test II contained one hundred eighty syllogisms in abstract form, as in the following examples:

1. AT PT I AF If all x's are y's;
   And if all z's are x's;
   Then all z's are y's.

2. AT PT I AF If no x's are y's;
   And if all z's are y's;
   Then some z's are x's.

Of the one hundred eighty items, one hundred twenty-eight were logically invalid, and the remaining fifty-two valid. Only the invalid forms were needed for the experimental analysis; but the valid items were included in the interest of sound testing procedure. The one hundred twenty-eight invalid items represented two examples each of the sixty-four possible arrangements of the four categorical propositions A, E, I, O (see page 12) as either of the premises or conclusion. These items provide every possible type of occurrence of atmosphere effect in formal syllogistic material.[25]

The items were arranged in random order with respect to difficulty. The test was mimeographed in four three-page booklets, in a uniform format of fifteen items per page. A cover page containing directions accompanied each booklet.[26] This is shown in the appendix, (page 60).

In addition to the directions on the cover page, which were read aloud by the experimenter at each session, the following directions were given:

[25] In the preparation of Test II no attempt was made to observe any rule concerning formal fallacies, since it was felt that these represent logical rather than psychological categories, and would be irrelevant to the psychological problem under investigation.

[26] A slight deviation from the multiple choice procedure of Test I was made, in that only four categories of response were used. In Test II the PF (probably false) category was not retained because of its very infrequent use in Test I.

You will come across statements of the type

Some x's are y's; or
Some x's are not y's.

The word *some* has a special meaning in logic, apart from its meaning in customary usage. In ordinary speech, *some* usually means *part;* that is, *some, but not all.* Thus we would be led to infer from a statement that *some are* the fact that *some are not,* and vice versa, from *some are not* that *some are.*

This partitive meaning of some is invalid in logic. The *logical* meaning of *some* is *distributive.* In logic, *some* means *at least some, and possibly all.* Thus the correct logical interpretation of *some* would imply that from a statement that *some are* we cannot infer the fact that *some are not,* since *some are* may mean that *all are.* And if this is true, it is impossible that *some are not.* And similarly, from the statement that *some are not,* we cannot infer that *some are,* for the same reason.

There were four experimental sessions, each one hour in length, from nine-thirty to ten-thirty o'clock, each morning on four successive days, December, 1934. The complete directions were read by the experimenter at the beginning of each session, and questions relevant to the understanding of the procedure were answered. Booklet I (items 1 to 45) was given on day 1, and Booklets II, III, and IV on the following days. Extra time was allowed to those who did not finish. Thus all were able to respond to every problem.

A group of sixty-five adults, regularly employed as subjects on an adult learning C.W.S. project at Teachers College, Columbia University, conducted by Dr. I. Lorge, served in these experiments as part of their regular experimental program. These persons were of both sexes, ranging in age from twenty-one to seventy, and ranging in intellect from CAVD three hundred seventy to CAVD four hundred thirty-eight. None of these subjects had any previous training in logic.

The scoring procedure in Test II was the same as in the preliminary investigation. The score was number right. Scores were

TABLE IX

THE MEAN AND S.D. AGE, INTELLECT CAVD, AND SYLLOGISM TEST SCORES FOR THE TOTAL GROUP. (N = 65)

	Mean	*S.D.*
Age (months)	431.14	156.64
Intellect CAVD	410.48	14.25
Syllogism (Total)	128.34	24.51
(odd)	64.14	12.62
(even)	64.20	12.46

computed separately for odd and even items. The correlation between odd and even item scores was .910. The reliability of the total test, stepped up by the Spearman-Brown formula is .953. The Mean and S.D. age, intelligence, and syllogism test scores for the total group are shown in Table IX. Comparison of Table IX with Table II (page 20) indicates that the subject groups of the main and preliminary experiments are comparable with respect to age and intelligence.

II. Experiment I. Demonstration of the Atmosphere Effect in Formal Syllogistic Reasoning

The complete data of the total group, for the one hundred twenty-eight invalid syllogisms in Test II, were tested for atmosphere effect following the analysis of Woodworth and Sells. This analysis is based upon the comparison of the percent of the group accepting each type of false conclusion from the same premises. For instance, two examples each of the following problems were given:

AAA	If all x's are y's; And if all z's are y's; Then all x's are z's.	Accepted by 58%
AAE	If all x's are y's; And if all z's are y's; Then no x's are z's.	Accepted by 14%
AAI	If all x's are y's; And if all z's are y's; Then some x's are z's.	Accepted by 63%
AAO	If all x's are y's; And if all z's are y's; Then some x's are not z's.	Accepted by 17%

The atmosphere structure of each of these problems is identical in the premises; but each has a different conclusion. Since all of the conclusions are invalid, they should all be accepted an equal number of times if only chance and no selective factors are operative. According to the hypothesis, however, certain false conclusions should be accepted with greater frequency following certain given types of premises, while the remaining possible alternatives in each case should be less frequently accepted. Atmosphere effect is then demonstrated to be operative when the frequency of acceptance of the hypothesized conclusions differs markedly from that of the other possible conclusions.

By hypothesis (see page 16) we should expect the following conclusions to be favored by atmosphere:

With premises AA—conclusion A (or weaker I)
With premises AE, EA, EE—conclusion E (or weaker O)
With premises AI, IA, II—conclusion I
With premises AO, OA, EI, IE, EO, OE, IO, OI, OO—conclusion O.

Further, from our definition of the atmosphere effect (page 7) as a set to complete a task "with that one of several alternative responses which is *most* similar to the general trend or tone of the whole problem", we should not only expect the 'proper' conclusion to be most frequently accepted, but also the *more* similar alternatives to be accepted more frequently than the less similar.[27]

The results are presented in Table X, which may be read in the same way as Tables VII and VIII (page 28). It will be seen that the results shown in Table X confirm the theoretical expectations based upon the hypothesis. In every case, the bold faced numbers, representing conclusions favored by atmosphere effect, are substantially greater than the percents accepting invalid conclusions not favored by atmosphere effect; and of the conclusions not 'favored', the percent of acceptance is greater for those which are *more similar* to the 'favored' conclusions. This latter fact may be observed, for example, where, with premises AI or IA (in which case atmosphere effect calls for acceptance of an I conclusion) the highest percent of acceptance occurs for the I conclusion, with A and O conclusions both second highest, and E conclusion lowest. Both A and O propositions are more similar to I than the E proposition, for, since I is particular affirmative, A resembles I in being affirmative, O resembles I in being particular, while E is neither particular nor affirmative. Similar comparisons may be made for every occurrence of atmosphere effect in Table X.

In Table X we have the opportunity to observe whether the order of the premises has any effect on atmosphere or on the acceptance of the conclusion. Woodworth and Sells, Table VIII, reported that the order of the premises seems to have little effect on the acceptance of the conclusion. This observation is amply corroborated in the present experiment. Consideration of the percents accepting each type of false conclusion for each pair of premises AE and EA, AI

[27] Similarity of conclusions may be considered in terms of two variables of quality: 1. positive-negative, and 2. universal-particular. Thus a statement may resemble another in either one, both, or neither of these qualities.

TABLE X

THE EFFECT OF ATMOSPHERE ON THE ACCEPTANCE OF INVALID CONCLUSIONS

Entries indicate the average percent accepting each type of false conclusion from the premises. Numbers in bold faced type indicate conclusions which, according to hypothesis, should be favored by atmosphere effect. The number of subjects is 65.

Premises	*Types of Invalid Conclusion*			
	A	*E*	*I*	*O*
AA	58	14	**63**	17
AE	11	**51**	13	**63**
EA	8	**64**	12	**69**
AI	33	4	**70**	32
IA	36	15	**75**	36
AO	15	26	42	**76**
OA	13	33	28	**75**
EE	21	**38**	25	**34**
EI	8	40	22	**62**
IE	11	42	22	**63**
EO	13	29	29	**44**
OE	15	31	24	**48**
II	27	9	**72**	**38**
IO	12	19	31	**64**
OI	11	23	33	**71**
OO	14	16	38	**52**

and IA, AO and OA, EI and IE, EO and OE, IO and OI, shows that the change in order has no observable effect.

Table X is summarized by reducing it from a 16×4 to a 4×4 fold table. This is done by averaging the entries of all lines which, by hypothesis, have the same atmosphere effect. The result, Table XI, is a table in which the categories along the vertical margin are theoretical and the categories along the horizontal margin are observed. Such a table has the advantage of showing the atmosphere effect very clearly, and may readily be tested for independence of the theoretical and observed distributions by the Chi Square test.

TABLE XI

THE EFFECT OF ATMOSPHERE ON THE ACCEPTANCE OF INVALID CONCLUSIONS

This table is a summary of Table X, obtained by averaging the entries of all lines which, by hypothesis, have the same atmosphere effect. The categories along the vertical margin are theoretical and those along the horizontal margin are observed. The number of subjects is 65.

Premises	*Types of False Conclusion*			
	A	*E*	*I*	*O*
A atmosphere	**58**	14	**63**	17
E atmosphere	13	**51**	17	**55**
I atmosphere	32	9	**72**	**35**
O atmosphere	12	29	30	**62**

The total value of Chi Square for the absolute frequencies of entries in Table XI is 105.70, while n′ (the number of degrees of freedom plus one) for a four by four fold distribution is 10. This indicates that the probability of the obtained distribution of errors occurring by chance is less than 10^{-6}.[28] We may therefore conclude that (a) the obtained distribution of errors diverges reliably from a chance distribution; and (b) the data lend strong support to the hypothesis.

The experimental conditions in the series of experiments reported in this chapter were controlled in the following respects: 1) all of the subjects were naive concerning the formal rules of logic; 2) the task of judging the conclusion was specifically stated in the directions; 3) the factor of the ambiguity of the word *some* was controlled by specific supplementary instructions; 4) the problems were all stated in a homogeneous abstract form, in uniform format, with similar terms; 5) the subjects were all interested in the tasks required of them; they were experienced in test procedure; there was a good 'rapport' between experimenter and subjects; 6) the test was conducted as a power test, ample time being allowed to all to respond to every problem.

However, although the conditions were standard, they were not optimum for the operation of atmosphere effect. The procedure of judging the *given* conclusion as true or false often tended to suggest an alternative to the subject which would not have occurred to him if the response had been a completion, *i.e.*, a free inference. This fact was clear in the protocols of several observers in another experiment who made introspective reports of their experiences in solving the problems. This experiment will be discussed later. Furthermore, the unlimited time procedure permitted the subjects to *analyze* the problems; many drew schemas and diagrams on the margins of the test blank. An analytic attitude in the solution of the problems is opposed to the optimal effect of atmosphere.

And yet, despite these sub-optimal conditions, the results presented in Tables X and XI furnish conclusive evidence for the operation of atmosphere effect. There are no exceptions in Table X or in its derivative, Table XI, which need to be accounted for by hypotheses ad hoc.[29] The hierarchy of percents accepting each

[28] *Cf.* Pearson, K. (17) Table XII, page 26.

[29] A possible exception is the acceptance of the weaker I where atmosphere effect calls for A, and of the weaker O from E. This exception was discussed above (page 29). However, in the introspective reports, to be discussed below, where free inferences were allowed, this type of "cautious" response did not oc-

type of false conclusion from the given premises is in every case in accordance with the expectations of the hypothesis.

That the atmosphere effect functions in the acceptance of valid as well as invalid conclusions is implicit in the hypothesis. Since there is a correspondence between the secondary hypotheses of atmosphere (page 16) to the effect that a) the presence of a negative proposition in the premises creates a negative atmosphere, and b) the presence of a particular proposition in the premises creates a particular atmosphere; and rules 6 and 7 for the validity of the syllogism (page 14), we should expect atmosphere effect to favor the acceptance of valid conclusions. Thus, whereas in the case of *invalid* conclusions, atmosphere effect is opposed to the correct logical relationship, in the case of *valid* conclusions the logical and psychological factors are generally in agreement.[30] This is objectively demonstrated by the fact that fewest errors occur in valid problems; *i.e.*, the valid items are easiest. In the preliminary experiment, in Table IV, based upon Syllogism Test I, the average percent of errors for category VII (Valid Conclusions) was 20.95 for abstract and 8.52 for concrete items. For category X (Universal Conclusion from a Particular Premise) which was the least difficult of the nine formal fallacies studied, the average percent of errors was 20.98 for abstract and 14.72 for concrete items. The average percent of errors for all forms in the test was 35.38 for abstract and 27.27 for concrete items.

Summary

1. The results of this experiment (Tables X and XI) demonstrate the operation of atmosphere effect in formal syllogistic reasoning.

2. When tested for independence from chance by the Chi Square method, the probability of the obtained distribution of errors occurring by chance is found to be less than 10^{-6}.

3. The order of the premises in a given formal structure is shown to have no influence on atmosphere effect. The percents accepting various conclusions from given premises do not change noticeably when the order of the premises is changed.

4. Because of a correspondence between the secondary hypoth-

cur. In the present procedure, where the conclusion is *given*, recognition of the correct logical relation of A to I and E to O would tend to include them, as explained in the text.

[30] It is possible to have a valid conclusion which is opposed to atmosphere effect in the strict sense; this is the case where a weaker particular is given in place of the correct universal.

eses of atmosphere and certain rules of the syllogism, atmosphere effect tends to facilitate the acceptance of valid conclusions.

III. Experiment II. The Influence of Intelligence upon Atmosphere Effect

The relation of success in solving syllogisms to intelligence has been discussed above (page 23). There is, in general, a high correlation between scores on syllogism tests and measures of intelligence. In this investigation, the correlation between abstract syllogism scores and Intellect CAVD was .633 in the preliminary analysis (Test I) and .756 for Test II. This indicates that more errors in the syllogism test were made by the 'dull' individuals and fewer by the 'bright.' It is therefore important to question whether the demonstration of atmosphere effect in Experiment I was genuine for the entire group, or whether it was merely the result of a greater number of errors made by the less intelligent part of the group.

The problem of the present experiment is to investigate this question. The procedure consisted in comparing the results of two selected groups at the extremes of the intelligence distribution. From the total population in Experiment I, two groups of sixteen subjects each, matched person for person on age and sex, but differing widely in intelligence, were chosen. The Mean and Range in age, CAVD, and syllogism test scores of the two groups are shown in Table XII. These two groups represent a very wide separation in intellect; the mean of the Bright group, 426, is above the mean of candidates for the Ph.D. degree at Columbia University, while the mean of the Dull group, 392, is below the mean of high school graduates in New York City.

The results of the sixteen individuals in each group were then separately tabulated and subjected to the same analysis as in

TABLE XII

The Mean and Range in Age, CAVD, and Syllogism Test Scores of Bright and Dull Matched Groups. The Number of Persons in Each Group is 16

	Bright Group			*Dull Group*		
	Low Score	*Mean*	*High Score*	*Low Score*	*Mean*	*High Score*
Age (years)	21	34	56	22	34	64
CAVD	421	426	437	370	392	404
Syllogism Test	131	153	180	84	106	141

Experiment I. In this way, while recognizing the superiority of the Bright group in terms of total frequency of errors, we could still inquire about the *distribution* of errors by testing the results of both groups for atmosphere effect.

Tables XIII and XIV show the results of the analysis of the data of both groups. These tables correspond to Tables X and XI, above. It is apparent that the operation of atmosphere effect is not seriously influenced by intelligence. While the total frequency of errors is greater for the Dull group than for the Bright, the distribution of errors in both groups conforms quite well with the expectations of the atmosphere hypothesis. Comparison of Table XIIIa and XIIIb reveals striking similarities and differences. The hierarchy of percents accepting invalid conclusions from the same premises is quite similar in both groups. However, the errors due to atmosphere effect seem to be greater in the Bright group than in the Dull. Whereas in the Dull group, even the most absurd and dissimilar conclusions are frequently accepted, these are rarely accepted by the Bright group. With but one exception the Bright group accepts the conclusions favored by atmosphere (shown in the table in bold faced type) with relatively high frequency. This exception is in the case

TABLE XIII

THE INFLUENCE OF INTELLIGENCE ON ATMOSPHERE EFFECT

Table A shows the effect of atmosphere on the acceptance of invalid conclusions in a Bright group of 16 subjects; Table B in a Dull group of 16 subjects. Entries are percents accepting the given conclusion from given premises. Bold faced numbers indicate conclusions favored by atmosphere effect.

Premises	A. *Bright Group*				B. *Dull Group*			
	Types of Invalid Conclusion							
	A	*E*	*I*	*O*	*A*	*E*	*I*	*O*
AA	28	0	31	10	72	31	81	28
AE	0	47	0	50	31	73	25	69
EA	0	47	3	50	16	63	22	81
AI	10	0	38	6	50	13	86	34
IA	6	0	73	10	50	25	79	63
AO	6	13	14	63	25	38	53	88
OA	0	19	13	66	22	44	44	66
EE	0	13	10	6	44	53	41	56
EI	0	16	0	50	19	56	44	69
IE	3	22	4	72	35	53	66	72
EO	3	0	0	28	28	53	59	59
OE	0	3	0	17	50	44	53	67
II	3	0	41	19	34	16	84	53
IO	3	3	10	47	25	44	47	69
OI	0	10	3	69	22	59	50	69
OO	0	0	10	34	38	34	69	75

of premises EE, where the frequency of acceptance of invalid conclusions is 0, 13, 10, and 6 per cent for A, E, I, O conclusions respectively.

In Table XV are shown the values of Chi Square for the absolute frequencies of the entries in Table XIV. These values indicate the contribution of each average occurrence of atmosphere effect to the total Chi Square of the distribution, which is expressed as the probability that the obtained distribution of errors deviates from a chance distribution. If the value is low, the frequency for the given cell of the table does not deviate much from chance expectation, and vice versa if the value is high. The total Chi Square for the Bright Group is 39.49, which is 2.33 times that for the Dull group, 17.33. Both distributions are significantly divergent from chance expectation; the value of P is .000008 for the Bright group and .048716 for the Dull group.[31] It is nevertheless important to note that the divergence from chance expectation, as measured by Chi Square, is tremendously greater in the case of the Bright group. This confirms the previous observation that atmosphere effect *seems* to be more marked in the Bright group.

TABLE XIV

THE INFLUENCE OF INTELLIGENCE ON ATMOSPHERE EFFECT

This table is a summary of Table XIII, obtained by averaging the entries of all lines which, by hypothesis, have the same atmosphere effect. Table A shows the effect of atmosphere on the acceptance of invalid conclusions in a Bright group of 16 subjects; Table B in a Dull group of 16 subjects. Entries are average percents accepting given conclusions from given premises.

Premises	A. *Bright Group*				B. *Dull Group*			
	Types of Invalid Conclusion							
	A	*E*	*I*	*O*	*A*	*E*	*I*	*O*
A atmosphere	28	0	31	10	72	31	81	28
E atmosphere	0	36	4	35	30	63	29	69
I atmosphere	6	0	57	12	45	18	83	50
O atmosphere	2	10	6	50	29	47	54	70

It would seem at first that this result is inconsistent. The atmosphere effect is a directive tendency which is opposed to the perception of the correct logical relations in these invalid problems. The Bright group were able to perceive the correct logical relations better than the Dull group, since they made fewer errors. Therefore the Bright group should be less susceptible to a set or tendency which is opposed to the perception of the correct logical relations. This con-

[31] *Cf.* Pearson, K., *op. cit.*

clusion would carry more weight if the atmosphere effect were the *only* factor in the situation which is opposed to the perception of the correct logical relations.

TABLE XV

THE VALUES OF CHI SQUARE FOR ABSOLUTE FREQUENCIES OF ENTRIES IN TABLE XIV

Premises	A. *Bright Group*				B. *Dull Group*			
	Types of Invalid Conclusion							
	A	*E*	*I*	*O*	*A*	*E*	*I*	*O*
A atmosphere ...	6.91	1.77	.38	1.54	2.20	.48	.58	2.43
E atmosphere ...	1.51	7.65	2.92	.28	.56	2.63	2.45	.91
I atmosphere ...	.20	1.92	6.16	1.46	.01	1.81	1.33	.03
O atmosphere ...	.80	.12	2.04	3.83	.82	.21	.16	.72
	Total Chi Square			39.49	Total Chi Square			17.33

However, in the analysis of the distribution of errors of the Dull group, the atmosphere effect is almost overshadowed by the wholesale and indiscriminate acceptance of invalid conclusions. The results (Table XV—B) actually demonstrate the operation of atmosphere effect in the data, but it is partially obscured by the acceptance of conclusions not favored by atmosphere effect. This result may be explained by the assumption of a general tendency among the Dull group to agree or to be gullible, which is probably negatively associated with intelligence.

The manner in which this assumed tendency-to-agree would obscure the effect of atmosphere in the data of the Dull group is as follows: Consider that there are only two psychological factors leading to the acceptance of invalid conclusions, 1—atmosphere effect, and 2—the tendency-to-agree. The tendency-to-agree is, by definition, not present (or at least negligible) in the Bright group. Then the only remaining factor in the Bright group is the atmosphere effect. Therefore whatever errors occur in the Bright group should show a clear atmosphere effect. In the Dull group, the tendency-to-agree is present, favoring the acceptance of *all* conclusions. In addition, the atmosphere effect favors the acceptance of *certain* false conclusions from given premises. Now, while the atmosphere effect favors the acceptance of certain invalid conclusions from given premises, it in effect opposes the acceptance of the other possible alternatives in each case. For example, with Premises AA, atmosphere effect would favor conclusion A and oppose conclusion E. But the acceptance of both A and E (and, in fact, any other

conclusion) is favored by the tendency-to-agree. Thus there are in the Dull group two kinds of cases:

1) in which the acceptance of invalid conclusions is favored by both atmosphere effect and the tendency-to-agree,
e.g. AAA
2) in which the acceptance of invalid conclusions is favored by the tendency-to-agree, but not favored by atmosphere effect.
e.g. AAE

The presence of both kinds of cases in Tables XIII—B and XIV—B has the result of reducing or obscuring the total amount of atmosphere effect in the Dull group. For, while the atmosphere effect is increased by occurrences of case 1, its presence in the table seems to be *decreased* by occurrences of case 2. This follows from the fact that the statistical evidence for atmosphere effect, the measures of Chi Square, are based upon the whole table; and thus the higher frequencies in the cells which are occurrences of case 2 lower the values of Chi Square, and seem to suggest less atmosphere effect.

The bold faced numbers in Tables XIV and XV represent types of false conclusions which are favored by atmosphere effect. In Tables XIV—B and XV—B these represent occurrences of case 1, while all the other entries are examples of case 2. If we regard the value of Chi Square for each individual entry in Table XV as a measure of the amount of atmosphere effect for the problems represented in the cell, we may see that for corresponding entries in the Bright and Dull groups, the atmosphere effect is much greater in the Bright group ten times out of sixteen, while there are no large negative deviations.

The tendency-to-agree with the stated conclusion receives support in the comparison of the success of both groups with *valid* as well as *invalid* conclusions. In the case of *invalid* conclusions the situation is probably as described above. The Bright persons are favored by superior ability to perceive the correct logical relations, but must overcome the atmosphere effect, which is opposed to the logically correct result; the Dull persons must overcome inferior ability, atmosphere effect, and this tendency-to-agree in order to solve the problems correctly. However, with *valid* conclusions, the Dull persons should be at less of a disadvantage. Whereas the Bright individuals again have superior ability, which is now accompanied by 'favorable' atmosphere effect, the inferior or Dull group

should have the tendency-to-agree as well as atmosphere effect in their favor, if this tendency is genuine. The average percent of errors for all *invalid* items was 17 for the Bright group and 50 for the Dull group; while for *valid* items, it was 13 for the Bright group and 22 for the Dull. The relative improvement of the Dull group from a ratio of 3 to 1 errors on *invalid* items to 1.7 to 1 on *valid* items with respect to the Bright group may tentatively be attributed to this tendency-to-agree of the less intelligent, which we may refer to as "gullibility."[32] However, while this evidence supports the assumption, the "gullibility" hypothesis must be considered a hypothesis until more conclusive proof is obtained.

Summary

1. Considered as a factor leading to the acceptance of invalid conclusions, the atmosphere effect is demonstrated to operate in a group of very high intellect as well as in a group of low intellect.

2. As shown by the Chi Square technique, the atmosphere effect seems to be more marked in the Bright group than in the Dull.

3. This is attributed to the fact that the errors due to atmosphere effect in the Dull group are obscured in the wholesale acceptance of invalid conclusions.

4. In this connection a factor of "gullibility", a tendency of the less intelligent to agree with a stated conclusion, is postulated.

5. A comparison of the success of both groups in solving *valid* as well as *invalid* conclusions furnishes evidence in support of this factor. However, until further proof is obtained, the "gullibility" hypothesis should be considered as a hypothesis.

IV. Experiment III. The Influence of Age on Atmosphere Effect

The problem of this experiment was to investigate the influence of age upon the distribution of errors in the acceptance of invalid conclusions, under the conditions of the present investigation. The procedure, with respect to selection of subjects and analysis of results, was the same as that of Experiment II.

[32] Further evidence in favor of "gullibility" was obtained from comparison of the responses of the two groups on a personality inventory. Through the courtesy of Dr. Lorge, the Bernreuter Personality Inventory was given to both groups, and the number of *Yes* responses made by each individual was tabulated. The mean number of *Yes* responses made by the Bright group was 45.47 (with a S.D. of 14.37), while that of the Dull group was 56.00 (with a S.D. of 16.16). Even with proper account taken of the correlation introduced by matching, the difference is 3.71 times the standard error of the difference, which indicates a reliably greater tendency of the Dull persons to say *Yes*.

From the total population in Experiment I, two groups of sixteen subjects each, matched person for person on intellect CAVD and sex, but differing widely in age, were selected. The Mean and Range in age, CAVD, and syllogism test scores for the two matched groups are given in Table XVI.

TABLE XVI

THE MEAN AND RANGE IN AGE, CAVD, AND SYLLOGISM TEST SCORES OF YOUNG AND OLD MATCHED GROUPS. THE NUMBER OF PERSONS IN EACH GROUP IS 16

	Young Group			*Old Group*		
	Low Score	*Mean*	*High Score*	*Low Score*	*Mean*	*High Score*
Age (years)	20	23	25	39	52	69
CAVD	398	412	430	395	412	429
Syllogism Test	90	138	165	92	129	171

The distribution of errors for each type of atmosphere effect in the Young and Old groups is shown in Tables XVII and XVIII. These results indicate that age does not have a significant influence

TABLE XVII

THE INFLUENCE OF AGE ON ATMOSPHERE EFFECT

Table A shows the effect of atmosphere on the acceptance of invalid conclusions in a Young group of 16 subjects; Table B in an Old group of 16 subjects. Entries are percents accepting the given conclusion from given premises. Bold faced numbers indicate conclusions favored by atmosphere effect.

Premises	A. *Young Group*				B. *Old Group*			
	Types of Invalid Conclusion							
	A	*E*	*I*	*O*	*A*	*E*	*I*	*O*
AA	53	13	69	9	50	9	53	19
AE	0	41	9	56	13	50	6	63
EA	6	63	9	53	6	63	13	66
AI	17	6	59	31	31	0	66	28
IA	28	3	75	25	38	6	72	34
AO	0	9	22	75	13	28	53	84
OA	3	22	16	88	13	31	31	81
EE	13	25	13	31	16	38	25	38
EI	3	31	6	31	6	31	22	50
IE	9	25	19	69	3	47	23	56
EO	6	19	25	22	13	34	25	53
OE	9	9	13	40	6	44	22	52
II	19	25	56	28	28	19	69	34
IO	3	6	13	63	9	22	31	53
OI	9	22	13	78	6	31	31	63
OO	9	9	25	50	13	13	35	53

upon atmosphere effect or upon the distribution of errors, under the conditions of the present research.[33]

In Table XVII—A we see that with premises EI and conclusions E and O, and with premises EO and conclusion O, the data of the Young group do not conform very well with the hypothesis; similarly, in Table XVII—B, with premises IE and conclusion E and with premises OE and conclusion E, for the data of the Old group. However, these exceptions may be regarded lightly because of the small size of the groups. When we observe the generalized results in Table XVIII, the inconsistencies are concealed in the average trend. Aside from the exceptions indicated, the obtained distributions of errors of both groups conform quite well with the expectations of the hypothesis.

In Table XIX we have the value of Chi Square for the absolute frequency of each entry in Table XVIII. It will be noted that

TABLE XVIII

THE INFLUENCE OF AGE ON ATMOSPHERE EFFECT

This table is a summary of Table XVII, obtained by averaging the entries of all lines which, by hypothesis, have the same atmosphere effect. Table A shows the effect of atmosphere on the acceptance of invalid conclusions in a Young group of 16 subjects; Table B in an Old group of 16 subjects. Entries are average percents accepting given conclusions from the given premises.

Premises	A. *Young Group*				B. *Old Group*			
	Types of Invalid Conclusion							
	A	*E*	*I*	*O*	*A*	*E*	*I*	*O*
A atmosphere	53	13	69	9	50	9	53	19
E atmosphere	6	43	10	47	12	50	15	59
I atmosphere	21	11	63	28	32	8	69	32
O atmosphere	6	17	16	53	9	31	30	61

although the total Chi Square of the Young group, 30.55, is slightly higher than that of the Old group, 26.01, indicating a greater divergence of the obtained distribution of errors in the Young group from chance expectation, nevertheless the values of Chi Square for corresponding entries in the Young and Old distributions agree quite closely, as an examination of Tables XIX—A and XIX—B will reveal. Referring the obtained values of Chi Square to Pearson's table of Goodness of Fit, we find that the value of P for the Young group is .000439 and for the Old group, .002043.[34] Thus the prob-

[33] See second footnote on page 26, above.

[34] *Cf.* Pearson, K., *ibid.*

ability that either distribution arose through chance factors does not exceed two chances in a thousand.

TABLE XIX

THE VALUES OF CHI SQUARE FOR ABSOLUTE FREQUENCIES OF ENTRIES IN TABLE XVIII

Premises	A. *Young Group*				B. *Old Group*			
	Types of Invalid Conclusion							
	A	*E*	*I*	*O*	*A*	*E*	*I*	*O*
A atmosphere ...	**4.18**	1.04	**1.32**	4.21	**3.99**	1.48	.61	1.96
E atmosphere ...	1.51	**4.75**	3.01	**1.27**	1.20	**4.13**	**2.82**	.93
I atmosphere ...	.02	.91	**1.72**	.30	.15	1.94	**2.35**	.58
O atmosphere ...	1.15	.01	1.19	**3.96**	1.64	.35	.44	**1.45**
	Total Chi Square			30.55	Total Chi Square			26.01

It is thus clear that our observations concerning the influence of age on atmosphere effect under the present experimental conditions are corroborated in the statistical analysis of the results.

The results of this experiment are consistent with the findings of the preliminary investigation on the relation of success on the syllogism test to age (page 25). The correlation of Test I with age was −.196, and of Test II with age −.220. These low negative correlations between syllogism test scores and age indicate a slightly greater total frequency of errors in the Old group. However, while there probably is a decline in ability to reason (i.e. to solve syllogisms) with advancing age, neither the correlations nor the obtained error distributions show any significant differential influence of age on atmosphere effect.

SUMMARY

1. The influence of age on the atmosphere effect was studied by comparing the distribution of errors in a group of Young subjects with the distribution of errors in an equated Old group of subjects.

2. Analysis of the data of both groups by the Chi Square method shows that the atmosphere effect occurs in the Young group as well as in the Old, and that the distribution of errors in the two groups is quite similar.

3. Under the conditions of the present research age is demonstrated to be a factor having negligible influence upon occurrence of the atmosphere effect.

V. Experiment IV. An Introspective Study of Atmosphere Effect

The foregoing evidence for atmosphere effect has been objective, consisting essentially in statistical analyses of the *effect* of atmosphere upon the acceptance of invalid conclusions. While these data serve an important function in providing quantitative information on a number of fundamental issues, they leave unanswered other equally important questions concerning the phenomenon, which must be studied by subjective methods. The most important of these concerns the possibility of an atmosphere effect being experienced, and if so, the nature of this experience. Centering around this basic problem are a number of specific questions, which must be discussed separately. In this section the protocols of several authors, including those of the writer, will be analyzed.

The literature of the Würzburg school, particularly in the researches of Marbe (12), Orth (16), Watt (36), and Ach (1), established as a psychological concept the conscious attitude, Bewusstseinslage. Watt's Aufgabe, the conscious task or purpose that precedes a conscious course, was thought of as setting up in the subject an Einstellung or 'set', which predisposes the organism toward one type of motor or conscious activity. But Einstellung and Müller's 'perseverative tendencies' (by means of which Watt tried to account for the way the initial Aufgabe carried over *unconsciously* to the intended end), and Ach's *determining tendency,* which are similar to our *atmosphere effect,* were not definitely conscious. These were determiners of behavior which were mostly inferred from the observers' reports, as means by which the conscious Aufgaben are carried out to completion. The subjective study of atmosphere effect may indicate more clearly its relation to set, Einstellung, and determining tendency.

Can an atmosphere effect be experienced? This question is answered generally at first, and then with specific reference to syllogistic reasoning. That atmosphere effects can be experienced seems to be indicated by the generality of experiences such as those reported in illustrations a and b, page 8. The reader will probably recognize this old puzzle:

Read and answer the following questions aloud:
1—What is the correct pronunciation of POLK?
(ans. *poke,* the l is silent)
2—How do you pronounce the word FOLK?
(ans. *foke,* the l is silent)
3—How do you pronounce the white of an egg? ————————.

Even if one recognizes that question 3 refers to the white instead of the yellow of an egg, there is a strong tendency to say yolk (with a silent l). Puzzles of this kind are very convincing because the subject immediately feels tricked upon discovering his error, and in this experience of having been tricked there may be present the awareness of an atmosphere effect.

However, there is a danger implicit in this example which is reminiscent of the criticism of numerous experiments in which the subjects were aware of the experimenter's purpose or hypothesis. This is that while the experience may seem to be apparent to one instructed in the nature of the atmosphere effect, it might not be noticed by a naive observer. The observers whose protocols are to be discussed in the following pages were unaware of the purpose of this experiment.

Series I. In this series there were seven observers, six male and one female, all college graduates, untrained in logic, and without specific training in psychology. The purpose of this experiment was to investigate the problem raised in the discussion of the completion type response (page 36) of whether this type of problem tends to make the responses of the group more homogeneous. The subjects were presented with the following problems:

1. AA All x's are y's;
   And all y's are z's;
   Therefore ————————.
2. AA All x's are y's;
   And all x's are z's;
   Therefore ————————.
3. EE No x's are y's;
   And no z's are x's;
   Therefore ————————.
4. II Some x's are y's;
   And some y's are z's;
   Therefore ————————.
5. OO Some x's are not y's;
   And some z's are not x's;
   Therefore ————————.

The problems were typewritten on cards. It may be seen that there are three possible valid conclusions to problem 1, a) All x's are z's, b) the weaker Some x's are z's, and c) the converse of b. There are two possible valid conclusions to problem 2, a) Some y's are z's, and b) the converse of a. Problems 3, 4, and 5 are invalid.[35]

[35] See rules for validity of the syllogism, page 14.

The experimenter gave the observer a card with a problem. The observer read the problem and reported a conclusion. The experimenter then asked whether any other conclusion was correct as well. Then, if the observer had reported an incorrect conclusion or alternative conclusion, he was told so, and asked if he observed his error.

Some results of this experiment are shown in Table XX. The most striking fact to be seen is the tendency to seek some conclusion, to complete the task. Several of the subjects stated that they would probably have judged the conclusion to the EE, II, and OO problems as false if these had been presented as T–F items, but felt that they

TABLE XX

THE RESPONSES OF SEVEN OBSERVERS TO COMPLETION TYPE PROBLEMS
Entries indicate the number of observers offering each type of conclusion for each set of premises, both as first conclusion and as an alternative.

Problem	*First Conclusion*					*Alternatives*			
	A	*E*	*I*	*O*	*None*	*A*	*E*	*I*	*O*
1. AA	7	0	0	0	0	0	0	2	0
2. AA	5	0	2	0	0	0	0	1	0
3. EE	0	5	0	1	1	0	0	1	0
4. II	0	0	6	1	0	0	0	0	1
5. OO	0	0	0	5	2	0	0	0	0

should make some response. It is clear that the procedure followed in this experiment, using free inference or completion type responses, favors the occurrence of atmosphere effect more than the True–False procedure used in Experiment I. With the problems used in this experiment the responses of the subjects tend to be quite homogeneous, and there is little tendency to even consider alternative conclusions to that which is chosen at first (and which is generally most favored by atmosphere effect).

The experimenter questioned each of the seven observers concerning his experiences in solving the problems. No standard procedure was followed and detailed protocols were not recorded. However, it appeared that this method would not yield any definite 'atmosphere' experiences. It was decided that problems with a more extreme atmosphere effect might be more fruitful. A new experiment was then undertaken.

Series II. In this experiment four *sorites* were used as problems. The sorites is similar in structure to the syllogism, but has a chain of premises.[36] The problems were as follows:

[36] *Cf.* Cohen and Nagel (5).

1. If all a's are b's;
   And all c's are a's;
   And all d's are c's;
   And all e's are d's;
   Then —— e's —— b's.
2. If all a's are b's;
   And some c's are a's;
   And all d's are c's;
   And some e's are d's;
   And all f's are e's;
   Then —— b's —— f's.
3. If all monkeys are bipeds;
   And some bipeds are mammals;
   And all mammals are warm-blooded;
   And some warm-blooded creatures are human;
   And all humans are mortal;
   Then —— monkeys —— mortal.
4. If all a's are b's;
   And all c's are a's;
   And all d's are c's;
   And all e's are d's;
   Then —— a's —— d's.

The observers were four graduate students in psychology, three male and one female. The problems were typewritten on cards. The experimenter gave the observer a problem with the instruction to complete the task with an appropriate conclusion. When the observer reported a conclusion, he was first asked to give a detailed report of his experience, and later, if his reported conclusion was wrong, informed of this and instructed to find the correct conclusion, following which another report was taken. The observer was asked particularly if he had observed anything which might be connected with the selection of the conclusion. The protocol of one observer is summarized. This observer is a graduate student in psychology. He has had previous training in introspection. The protocol for each problem is given in order:

Problem 1 On coming to the second line of this sorites, I had an image or concept of an angle formed by two diverging lines, the apex representing *a*, while each of the lines represented the inclusion within *a* of *b* and *c*, without any necessary overlap between these latter. From this point I progressed through the remaining two lines, extending the line a–c by an additional segment for each of them, so that I arrived at the end with the feeling that all e's are a's, but that the relation of c's, d's, and e's to b's remained uncertain. I therefore reported that no conclusion was possible. On being told

that some conclusion was possible, I was at first incredulous, but, being given the answer, I then saw its correctness and attributed my error to the fact that the schema which I had used from the beginning had led me to feel that a's were divided into b's and c's (with overlap possible, but indeterminate) rather than that a's were all included in b's.

Problem 2. I read through the second sorites without trying to draw any conclusion, with a feeling of wariness because of my first error, but drawing the tentative conclusion as I came to the second "some" that this would make any valid conclusion impossible. This was not based upon logical training, but again on a schema, though the schema I used now was more conventional, and influenced no doubt by the very small amount of logic I had learnt (the use of circles to represent classes). These circles had a quasi-visual existence, being colorless and without brightness or line, but existing somewhere in the space above the card which I held before my eyes. Feeling the impossibility of a conclusion, I went backward through the sorites, now without any schema, but analytically, confirming my view as soon as I reached "Some e's are d's" in this reverse direction, since the e's might be different from those which are f's. However, I went carefully through to the beginning, since I was hesitant to give again the same statement I had made for the first sorites.

Problem 3. I had a tentative conclusion ("no conclusion possible") as soon as I had reached the second line. I read through this hurriedly remarking after this reading that I knew the factual answer but not that called for by the premises, but feeling no compulsion to fill in this answer. Rereading, I decided after the second line that no conclusion was possible, and read the rest only in a cursory fashion to make sure that "bipeds" would not recur. Despite the conflict of the conclusion with the known fact, I had considerably greater subjective certainty in this case, where I had concrete materials to handle, than with the letters. No schema was needed or used for this problem. The similarity of this problem to problem 2 was not noted. In neither 2 nor 3 was the rhythmic appearance of all-some-all-some-etc. in the premises noted.

Problem 4. I read this problem with the use of a circle schema from the start, and the final line, calling for a conclusion about a's and d's, was read with some annoyance, because of the realization that there had been much irrelevant material. The conclusion that "Some d's are a's" (and vice-versa) came when I noticed that the first and fourth lines were not needed. I reread the second and third lines in that order and saw with some relief that it was at last possible for me to say something other than "no conclusion possible."

Neither in this protocol, nor in those of the other observers was any experience reported which might be interpreted as an *atmosphere* experience. In problem 1, the observers offered conclusions

which would be called for by the hypothesis, but, as in the case of the observer shown, the responses to problems 2, 3, and 4 were complex. The very condition of being presented with a long, complicated appearing string of premises was discomforting. In problem 4 especially, the reluctance to offer an A conclusion (where atmosphere effect would indicate A) was accompanied by an additional annoyance as a result of noticing that the terms *a* and *d* were not appropriate to the *valid* conclusion.

There are several interesting facts issuing from the introspective reports. First, the atmosphere effect, in problems such as 2 and 3 (AIAIA), seems to be decreased by the very complex structure of the problem. Problems of this type need to be studied more in detail and will probably contribute significant facts to the understanding of atmosphere effect. If the rhythmic presentation of different premises, *e.g.*, AIAI, etc., or EAEA, etc., tends to weaken atmosphere effect, it would be important to understand how and why. It would also be interesting to inquire whether the addition of premises of the same type, *e.g.*, AAAA, tends to strengthen or increase the atmosphere effect.

Secondly, all of the observers reported greater subjective certainty and ease in dealing with the concrete terms in problem 3. This observation corroborates the statistical results obtained by Wilkins (38) and by the author (page 21).

A third point is related to the statement made above (page 34) regarding the influence of the order of the premises on atmosphere effect. It was found that changing the order of the premises did not influence the effect of atmosphere on the acceptance of invalid conclusions. A possible explanation of this, inferred from the introspective reports, consists in the fact that the subjects read the problem backwards from conclusion to first premise as well as forwards in searching for a conclusion. The premises are not considered as isolated parts, independent of each other, but rather the problem is studied as a whole. This frequently involved the use of schemas, which is the next point.

In the protocols of problems 1, 2, and 4 of the observer quoted, there is reported a tendency to use some type of *schema* in the solution of the problem. This tendency was noted in the reports of the other observers and is reported as well by several writers, including Störring (30), Eidens (6), Wertheimer (37B), and Flach (7). Several examples are quoted from Störring (30).

Stimulus: "Q is to the right of M
G is to the right of Q
Therefore . . .

O's report was localized to the right of M on the exposed card; G was then localized, and to the right of this, Q, so that there was an imaginary row, M . . . Q . . . G, from which total situation the fact was read off that G is to the right of M. Feeling of certainty.

Stimulus: "p is larger than o
i is smaller than o
Therefore . . .

O's report: On reading the first premise a sensation of expansion of the chest, as in inspiration, with a feeling of pleasure, was experienced. On reading the second premise a feeling of contraction. First premise read again with renewed sensation of pleasurable expansion. On looking again at the second premise there were unpleasant sensations of contraction connected with both o and i, but i was connected with the strongest contraction. The conclusion was read off from the progressive sensation of contraction. Feeling of certainty.

Stimulus: "All p belong to the class a
All a belong to the class d
Therefore . . .

O's report: On reading the first premise the class a was represented by a circle, with the letter p inside. Similarly, on reading the second premise, the class d was represented by a circle with the letter a inside. The circles, so far, were not interrelated, and the O was aware that the relation of the premises was not yet represented in the diagram. Premises were read a second time, a third time, and then a comprehensive diagram appeared, p inside the circle a, which, in turn was inside the larger circle d. The conclusion "All p belong to the class d," was read off from this picture of the whole situation. Feeling of certainty.

Numerous processes are reported by the observers. The processes differ somewhat with the type of relations presented in the premises, and individuals also differ in their proneness to make use of one or another process. However, the schema serves to build up a total pattern from which the relation required for the solution is "read off" (as the observers often expressed it) or "lifted out."

The schema may frequently lead to a false or invalid conclusion. This occurred in the attempt of problem 1 by the observer cited above. In cases such as this the conclusion chosen by the subject is appropriate to the total pattern built up, but is nevertheless invalid. It may be that there is a causal relationship between the atmosphere effect and the schema or general, total pattern in the observer's

experience. There are no data relevant to this consideration at the present time, but this is an important theoretical problem, and should be followed up in further research. We may further note in this connection a possible relationship between atmosphere effect and Wertheimer's Umzentrierung.[37]

Summary

1. In two series of experiments in which observers gave introspective reports of their experiences in solving syllogistic problems, no records were obtained which could be interpreted as indicative of an 'atmosphere' experience.

2. The atmosphere effect is thus regarded (until further revision should be indicated by subsequent experiments) as not reportable in experience.

3. In this connection a relationship with *Einstellung* or *determining tendency,* which are also not reportable in experience, is noted.

4. Problems of theoretical importance, which go beyond the scope of the present research, are suggested. One of these is concerned with the relationship between atmosphere effect and the structure of the problem; another with the connection between atmosphere effect (which is not reported in experience) and the schema or pattern built up in experience. In this connection the relevance of this material to the Gestalt theory of reasoning, as stated by Wertheimer, is noted.

5. In series I of Experiment IV it was found that the responses of a group to syllogistic problems requiring free inferences tended to be more homogeneous than in the True–False procedure.

[37] *Cf.* Wertheimer, M. Uber Schlussprozesse im produktiven Denken (37B).

CHAPTER IV

Summary and Conclusions

1. The problem of this investigation was to check the validity of the atmosphere hypothesis and to analyze the conditions of the atmosphere effect in reasoning with formal syllogistic problems.

2. The atmosphere effect is a dynamic behavior tendency toward a certain direction or specific type of response, descriptively characterized as belonging to the same genus as that described by the terms set, Einstellung, attitude, disposition, determining tendency, directive tendency, halo effect, perseveration, but differing from each of these in a specific manner.

3. The atmosphere effect was defined (page 7) as "a temporary set of the individual, arising within a situation (*e.g.*, problem) to complete a task with that one of several alternative responses (*e.g.*, a judgment or inference) which is most similar to the general trend or tone of the whole situation (*e.g.*, problem)."

4. The atmosphere hypothesis was formulated to account for the acceptance of *invalid* conclusions of formal syllogisms in terms of atmosphere effect.

5. Detailed summaries of the experimental results have been presented above. (See pages 27, 37, 43, 46, 54.)

6. The subjects of the preliminary investigation and Experiments I, II, and III were groups of adults employed as subjects on an adult learning project at Teachers College, Columbia University, who had no previous training in logic. The subjects of Experiment IV were seven college graduates, untrained in logic and in psychological observation, and four graduate students in psychology, untrained in logic.

7. The results of the experiments reported, while offering unequivocal objective evidence for the atmosphere effect in formal syllogistic reasoning, fail to reveal subjective evidence for it as a reportable datum of experience.

8. The objective evidence for the effect of atmosphere on the acceptance of invalid conclusions was found to be very conclusive, the probability of a distribution of errors, such as that obtained for the total group in Experiment I, arising through chance was shown by the Chi Square test to be almost infinitesmal.

9. Experiments II and III demonstrated that atmosphere effect operates in Bright as well as less intelligent, and in Young as well as Old adults.

10. Comparison of the data of a selected group of Bright subjects with those of a matched Dull group in Experiment II indicated greater effect of atmosphere in the *Bright* group. Further analysis of the data, however, showed that whereas the errors of the Bright group could be almost entirely accounted for by the atmosphere hypothesis, at least one additional factor was necessary to account for the errors of the Dull group.

11. In this connection, a factor called "gullibility" or a tendency-to-agree, which is negatively associated with intelligence, was postulated. Although there is some evidence in favor of this assumption, it is put forward as a hypothesis to be tested in further research.

12. In Experiment IV two series of experiments in which subjects gave introspective reports of their experiences in solving problems are reported. In none of the introspective records was any experience reported which might be interpreted as an 'atmosphere' experience. The same conclusion was reached in the examination of the protocols of Störring.

13. In the protocols of the observers of these experiments, and in several quoted from Störring, frequent use of *schemas* in the solution of problems was noted. Numerous processes were reported by the observers, differing with the type of relations in the premises and from individual to individual.

14. The schema frequently leads to an incorrect conclusion.

15. The need is recognized of further research on the relation of schemas (or total patterns) built up in experience to the behavior underlying the atmosphere effect.

16. The tendency of the subjects to react to the problem as a whole, and to build up a total pattern or a schema, further suggests a relationship with the Gestalt theory of reasoning, as stated by Wertheimer.

While this investigation may be considered as a contribution to the psychology of reasoning, in demonstrating the effect of atmosphere on the acceptance of conclusions in reasoning with formal syllogistic problems, it must nevertheless be emphasized that the results obtained, far from possessing finality, are much rather a point of departure for further researches in this field. Some of the problems have been formulated in the text, others are suggested, and new ones will undoubtedly arise in the consideration and interpretation of new results.

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APPENDIX A

The following table gives a complete description of each item in Test II and its percent difficulty value in terms of the total population of sixty-five subjects in Experiment I. Each entry gives the item number, type of syllogism, figure of the syllogism (with respect only to position of the middle term), logical status (i.e., true or false), and percent difficulty value. Thus item 1 (1. AAA 1 (T) 6%) is a syllogism of the mood AAA, first figure, true, difficulty value—6%. Item 7 (7. I(I) (T) 11) is a conversion from proposition I to I, true, difficulty value—11%. These two examples illustrate every item in the table.

The number 1, 2, 3, or 4, following the letters which describe the mood of the syllogism, represents the figure of the syllogism with respect to the position of the middle term. The four positions are illustrated diagrammatically:

Let P denote the major term,
S denote the minor term,
M denote the middle term.

1st fig.	2nd fig.	3rd fig.	4th fig.	
M P	P M	M P	P M	(Major premise)
S M	S M	M S	M S	(Minor premise)
S P	S P	S P	S P	(Conclusion)

SYLLOGISM TEST II. KEY AND ITEM NORMS

1. AAA 1 (T) 6%	23. IAO 3 (F) 31%	45. OOI 2 (F) 40%
2. EAE 2 (T) 6	24. AAA 2 (F) 62	46. AOE 2 (F) 35
3. IAA 3 (F) 46	25. AOO 1 (F) 79	47. E(E) (T) 12
4. AII 4 (F) 75	26. EIO 2 (T) 23	48. IEA 4 (F) 9
5. EEE 2 (F) 35	27. IOO 4 (F) 71	49. IOI 1 (F) 28
6. IEO 4 (F) 63	28. OIO 3 (F) 66	50. EEA 3 (F) 20
7. I(I) (T) 11	29. IEO 4 (T) 15	51. OAO 2 (T) 20
8. OIE 2 (F) 25	30. AAI 2 (F) 66	52. IAE 2 (F) 17
9. IIO 1 (F) 40	31. AOO 3 (T) 17	53. AIO 1 (F) 28
10. AOO 2 (T) 14	32. III 4 (F) 69	54. AEI 4 (F) 9
11. AEE 3 (F) 57	33. EAA 3 (F) 9	55. IAI 3 (T) 17
12. EAI 2 (F) 12	34. EIO 3 (F) 60	56. OII 3 (F) 34
13. AOO 4 (F) 74	35. EAO 2 (T) 20	57. OAO 1 (F) 75
14. OEE 3 (F) 35	36. IEI 1 (F) 28	58. AEE 4 (T) 9
15. IAI 3 (T) 12	37. EAO 3 (F) 62	59. EOO 1 (F) 51
16. OOO 1 (F) 54	38. A(I) (T) 12	60. OOE 2 (F) 17
17. E(O) (T) 25	39. OAI 1 (F) 74	61. IOA 1 (F) 15
18. EIA 1 (F) 12	40. IIA 2 (F) 29	62. OOA 4 (F) 15
19. EOO 4 (F) 37	41. OAE 3 (F) 37	63. EAO 4 (T) 28
20. AAI 1 (T) 12	42. AEO 1 (F) 63	64. IAI 2 (F) 69
21. AEE 2 (T) 12	43. AII 1 (T) 14	65. EAE 4 (F) 68
22. OAA 2 (F) 14	44. AIE 3 (F) 2	66. OAO 2 (T) 9

SYLLOGISM TEST II. KEY AND ITEM NORMS—(*Continued*)

67.	IEE	3	(F)	46%	105.	IOA	2	(F)	9%	143.	AEO	3	(T)	20%
68.	OEO	4	(F)	45	106.	EAA	1	(F)	8	144.	IOI	2	(F)	34
69.	EOA	2	(F)	19	107.	IAI	4	(T)	9	145.	AEO	4	(T)	19
70.	A(I)		(T)	22	108.	EEO	2	(F)	32	146.	IIA	1	(F)	25
71.	AOI	1	(F)	43	109.	EIE	4	(F)	42	147.	AAO	2	(F)	17
72.	EEI	4	(F)	26	110.	AEE	4	(T)	8	148.	OOA	1	(F)	12
73.	OEO	2	(F)	48	111.	OIO	1	(F)	75	149.	IEO	1	(T)	28
74.	AIA	2	(F)	34	112.	IAI	1	(F)	80	150.	EOI	2	(F)	25
75.	IOE	1	(F)	25	113.	OEE	1	(F)	26	151.	OAE	1	(F)	29
76.	AAE	3	(F)	11	114.	IOO	1	(F)	57	152.	AAI	3	(T)	12
77.	AAI	3	(T)	11	115.	EAO	1	(T)	17	153.	AOE	3	(F)	17
78.	IIE	2	(F)	9	116.	AII	2	(F)	65	154.	OEA	4	(F)	12
79.	EOE	1	(F)	29	117.	IAA	2	(F)	26	155.	IIO	2	(F)	37
80.	AOA	2	(F)	15	118.	OEI	3	(F)	20	156.	AIE	1	(F)	6
81.	AAO	3	(F)	17	119.	AII	3	(T)	9	157.	OII	2	(F)	32
82.	AEE	2	(T)	23	120.	IEA	1	(F)	12	158.	EIO	4	(T)	23
83.	OEA	2	(F)	17	121.	AIA	1	(F)	34	159.	IOE	2	(F)	14
84.	EOI	1	(F)	34	122.	IEI	2	(F)	17	160.	EEO	1	(F)	35
85.	EAE	1	(T)	15	123.	OIA	1	(F)	6	161.	E(O)		(T)	14
86.	AEA	4	(F)	9	124.	EEI	1	(F)	25	162.	AAI	4	(T)	8
87.	OIA	2	(F)	15	125.	EIO	3	(T)	23	163.	EAI	3	(F)	12
88.	AAA	1	(F)	55	126.	AAE	4	(F)	17	164.	OIE	1	(F)	22
89.	AEI	2	(F)	17	127.	IEE	1	(F)	37	165.	EOE	2	(F)	29
90.	OOO	3	(F)	51	128.	OAO	3	(T)	12	166.	IEO	3	(T)	23
91.	AEO	2	(T)	31	129.	A(I)		(T)	14	167.	AEA	2	(F)	12
92.	IAE	3	(F)	14	130.	EAE	3	(F)	60	168.	EIO	4	(F)	63
93.	EII	2	(F)	26	131.	OOI	1	(F)	35	169.	IEI	2	(F)	22
94.	E(E)		(T)	11	132.	AIO	2	(F)	35	170.	EIA	3	(F)	5
95.	AOI	3	(F)	42	133.	IIE	1	(F)	9	171.	AAI	1	(T)	8
96.	III	1	(F)	74	134.	AIA	4	(F)	32	172.	IAO	1	(F)	42
97.	EEE	4	(F)	40	135.	E(E)		(T)	14	173.	EAO	4	(F)	77
98.	OAA	1	(F)	12	136.	EII	3	(F)	17	174.	OEI	1	(F)	28
99.	IAI	4	(T)	3	137.	OAO	3	(T)	19	175.	AAI	4	(T)	12
100.	I(I)		(T)	14	138.	EOA	4	(F)	8	176.	OEO	1	(F)	51
101.	AAA	1	(T)	9	139.	AAI	2	(F)	60	177.	EEA	2	(F)	22
102.	OAO	3	(T)	20	140.	EIO	1	(T)	22	178.	OAO	2	(T)	15
103.	OAI	2	(F)	29	141.	OOE	3	(F)	15	179.	A(A)		(F)	33
104.	AEE	1	(F)	45	142.	EIE	2	(F)	39	180.	AAA	4	(T)	8

APPENDIX B. SYLLOGISM TEST II

Name ..... Date .....

School ..... Class .....

You are to read paragraphs, each of which ends in a conclusion which is supposed to follow from the preceding statements in the paragraph. Your problem is to decide whether the conclusion does follow. The truth or falsity of the conclusion depends upon whether or not it follows from the premises.

Example: If all x's are y's;
And if all y's are z's;
Then all x's are z's.

In the above example, the conclusion that all x's are z's does follow from the preceding statements. Sometimes other conclusions may be truer or better than the one given. You are, however, only to decide about the conclusion stated.

Preceding each paragraph, you will find a line with the letters, AT, PT, I, AF.

AT means absolutely true.
PT means probably true.
I means indeterminate.
AF means absolutely false.

If you think that the conclusion is absolutely true on the basis of the statements, put a circle around the letters AT. If you think that the conclusion is probably true, put a circle around the letters PT. If the conclusion is neither true nor false from the statements on which it is based, put a circle around I. If the conclusion is absolutely false from the statements on which it is based, put a circle around the letters AF.

You will come across statements of the type.

All x's are y's.

This means that every member of the class called x is also a member of the class called y. For instance, the statement

All men are mammals

means that each and every member of the class of men is included in the class of mammals.

Answer every question with care. Do not skip any. Work as rapidly as you can without making mistakes.

DO NOT TURN THIS PAGE UNTIL THE SIGNAL IS GIVEN

1.	AT	PT	I	AF	If all x's are y's, And if all z's are x's; Then all z's are y's.
2.	AT	PT	I	AF	If no x's are y's, And if all z's are y's; Then no z's are x's.
3.	AT	PT	I	AF	If some x's are y's, And if all x's are z's; Then all y's are z's.
4.	AT	PT	I	AF	If all x's are y's, And if some y's are z's; Then some x's are z's.
5.	AT	PT	I	AF	If no x's are y's, And if no z's are y's; Then no z's are x's.
6.	AT	PT	I	AF	If some x's are y's, And if no y's are z's; Then some z's are not x's.
7.	AT	PT	I	AF	If some x's are y's, Then some y's are x's.
8.	AT	PT	I	AF	If some x's are not y's, And if some z's are y's; Then no x's are z's.
9.	AT	PT	I	AF	If some x's are y's, And if some z's are x's; Then some z's are not y's.
10.	AT	PT	I	AF	If all x's are y's, And if some z's are not y's; Then some z's are not x's.
11.	AT	PT	I	AF	If all x's are y's, And if no x's are z's; Then no y's are z's.
12.	AT	PT	I	AF	If no x's are y's, And if all z's are y's; Then some x's are z's.

13. AT PT I AF
If all x's are y's,
And if some y's are not z's;
Then some x's are not z's.

14. AT PT I AF
If some x's are not y's,
And if no x's are z's;
Then no y's are z's.

15. AT PT I AF
If some x's are y's,
And if all x's are z's;
Then some y's are z's.

16. AT PT I AF
If some x's are not y's,
And if some z's are not x's;
Then some z's are not y's.

17. AT PT I AF
If no x's are y's,
Then some y's are not x's.

18. AT PT I AF
If no x's are y's,
And if some z's are x's;
Then all z's are y's.

19. AT PT I AF
If no x's are y's,
And if some y's are not z's;
Then some x's are not z's.

20. AT PT I AF
If all x's are y's,
And if all z's are x's;
Then some z's are y's.

21. AT PT I AF
If all x's are y's,
And if no z's are y's;
Then no z's are x's.

22. AT PT I AF
If some x's are not y's,
And if all z's are y's;
Then all z's are x's.

23. AT PT I AF
If some x's are y's,
And if all x's are z's;
Then some y's are not z's.

24. AT PT I AF
If all x's are y's,
And if all z's are y's;
Then all x's are z's.

25. AT PT I AF
If all x's are y's,
And if some z's are not x's;
Then some z's are not y's.

26. AT PT I AF
If no x's are y's,
And if some z's are y's;
Then some z's are not x's.

27. AT PT I AF
If some x's are y's,
And if some y's are not z's;
Then some x's are not z's.

28. AT PT I AF
If some x's are not y's,
And if some x's are z's;
Then some z's are not y's.

29. AT PT I AF
If some x's are y's,
And if no y's are z's;
Then some x's are not z's.

30. AT PT I AF
If all x's are y's,
And if all z's are y's;
Then some x's are z's.

31. AT PT I AF
If all x's are y's,
And if some x's are not z's;
Then some y's are not z's.

32. AT PT I AF
If some x's are y's,
And if some y's are z's;
Then some x's are z's.

33. AT PT I AF
If no x's are y's,
And if all x's are z's;
Then all y's are z's.

34. AT PT I AF
If no x's are y's,
And if some x's are z's;
Then some y's are not z's.

35. AT PT I AF
If no x's are y's,
And if all z's are y's;
Then some z's are not x's.

36. AT PT I AF
If some x's are y's,
And if no z's are x's;
Then some z's are y's.

37. AT PT I AF
If no x's are y's,
And if all x's are z's;
Then some y's are not z's.

38. AT PT I AF
If all x's are y's,
Then some y's are x's.

39. AT PT I AF
If some x's are not y's,
And if all z's are x's;
Then some z's are y's.

40. AT PT I AF
If some x's are y's,
And if some z's are y's;
Then all x's are z's.

41. AT PT I AF
If some x's are not y's,
And if all x's are z's;
Then no y's are z's.

42. AT PT I AF
If all x's are y's,
And if no z's are x's;
Then some z's are not y's.

43. AT PT I AF
If all x's are y's,
And if some z's are x's;
Then some z's are y's.

44. AT PT I AF
If all x's are y's,
And if some x's are z's;
Then no y's are z's.

45. AT PT I AF
If some x's are not y's,
And if some z's are not y's;
Then some x's are z's.

46. AT PT I AF
If all x's are y's,
And if some z's are not y's;
Then no z's are x's.

47. AT PT I AF
If no x's are y's,
Then no y's are x's.

48. AT PT I AF
If some x's are y's,
And if no y's are z's;
Then all x's are z's.

49. AT PT I AF
If some x's are y's,
And if some z's are not x's;
Then some y's are z's.

50. AT PT I AF
If no x's are y's,
And if no x's are z's;
Then all y's are z's.

51. AT PT I AF
If some x's are not y's,
And if all z's are y's;
Then some x's are not z's.

52. AT PT I AF
If some x's are y's,
And if all z's are y's;
Then no x's are z's.

53. AT PT I AF
If all x's are y's,
And if some z's are x's;
Then some z's are not y's.

54. AT PT I AF
If all x's are y's,
And if no y's are z's;
Then some x's are z's.

55. AT PT I AF
If some x's are y's,
And if all x's are z's;
Then some y's are z's.

56. AT PT I AF
If some x's are not y's,
And if some x's are z's;
Then some y's are z's.

57. AT PT I AF
If some x's are not y's,
And if all z's are x's;
Then some z's are not y's.

58. AT PT I AF
If all x's are y's,
And if no y's are z's;
Then no x's are z's.

59. AT PT I AF
If no x's are y's,
And if some z's are not x's;
Then some z's are not y's.

60. AT PT I AF
If some x's are not y's,
And if some z's are not y's;
Then no x's are z's.

61. AT PT I AF
If some x's are y's,
And if some z's are not x's;
Then all z's are y's.

62. AT PT I AF
If some x's are not y's,
And if some y's are not z's;
Then all x's are z's.

63. AT PT I AF
If no x's are y's,
And if all y's are z's;
Then some z's are not x's.

64. AT PT I AF
If some x's are y's,
And if all z's are y's;
Then some x's are z's.

65. AT PT I AF
If no x's are y's,
And if all y's are z's;
Then no x's are z's.

66. AT PT I AF
If some x's are not y's,
And if all z's are y's;
Then some x's are not z's.

67. AT PT I AF
If some x's are y's,
And if no x's are z's;
Then no y's are z's.

68. AT PT I AF
If some x's are not y's,
And if no y's are z's;
Then some x's are not z's.

69. AT PT I AF
If no x's are y's,
And if some z's are not y's;
Then all x's are z's.

70. AT PT I AF
If all x's are y's,
Then some y's are x's.

71. AT PT I AF
If all x's are y's,
And if some z's are not x's;
Then some z's are y's.

72. AT PT I AF
If no x's are y's,
And if no y's are z's;
Then some x's are z's.

73. AT PT I AF
If some x's are not y's,
And if no z's are y's;
Then some x's are not z's.

74. AT PT I AF
If all x's are y's,
And if some z's are y's;
Then all x's are z's.

75. AT PT I AF
If some x's are y's,
And if some z's are not x's;
Then no z's are y's.

76. AT PT I AF
If all x's are y's,
And if all x's are z's;
Then no y's are z's.

77. AT PT I AF
If all x's are y's,
And if all x's are z's;
Then some z's are y's.

78. AT PT I AF
If some x's are y's,
And if some z's are y's;
Then no x's are z's.

79. AT PT I AF
If no x's are y's,
And if some z's are not x's;
Then no y's are z's.

80. AT PT I AF
If all x's are y's,
And if some z's are not y's;
Then all x's are z's.

81. AT PT I AF
If all x's are y's,
And if all x's are z's;
Then some y's are not z's.

82. AT PT I AF
If all x's are y's,
And if no z's are y's;
Then no z's are x's.

83. AT PT I AF
If some x's are not y's,
And if no z's are y's;
Then all z's are x's.

84. AT PT I AF
If no x's are y's,
And if some z's are not x's;
Then some z's are y's.

85. AT PT I AF
If no x's are y's,
And if all z's are x's;
Then no z's are y's.

86. AT PT I AF
If all x's are y's,
And if no y's are z's;
Then all x's are z's.

87. AT PT I AF
If some x's are not y's,
And if some z's are y's;
Then all x's are z's.

88. AT PT I AF
If all x's are y's,
And if all z's are x's;
Then all y's are z's.

89. AT PT I AF
If all x's are y's,
And if no z's are y's;
Then some x's are z's.

90. AT PT I AF
If some x's are not y's,
And if some x's are not z's;
Then some y's are not z's.

91. AT PT I AF
If all x's are y's,
And if no z's are y's;
Then some z's are not x's.

92. AT PT I AF
If some x's are y's,
And if all x's are z's;
Then no y's are z's.

93. AT PT I AF
If no x's are y's,
And if some z's are y's;
Then some x's are z's.

94. AT PT I AF
If no x's are y's,
Then no y's are x's.

95. AT PT I AF
If all x's are y's,
And if some x's are not z's;
Then some y's are z's.

96. AT PT I AF
If some x's are y's,
And if some z's are x's;
Then some z's are y's.

97. AT PT I AF
If no x's are y's,
And if no y's are z's;
Then no x's are z's.

98. AT PT I AF
If some x's are not y's,
And if all z's are x's;
Then all z's are y's.

99. AT PT I AF
If some x's are y's,
And if all y's are z's;
Then some x's are z's.

100. AT PT I AF
If some x's are y's,
Then some y's are x's.

101. AT PT I AF
If all x's are y's,
And if all z's are x's;
Then all z's are y's.

102. AT PT I AF
If some x's are not z's,
And if all x's are y's;
Then some y's are not z's.

103. AT PT I AF
If some x's are not y's,
And if all z's are y's;
Then some z's are x's.

104. AT PT I AF
If all x's are y's,
And if no z's are x's;
Then no z's are y's.

105. AT PT I AF
If some x's are y's,
And if some z's are not y's;
Then all x's are z's.

106. AT PT I AF
If no x's are y's,
And if all z's are x's;
Then all y's are z's.

107. AT PT I AF
If some x's are y's,
And if all y's are z's;
Then some z's are x's.

108. AT PT I AF
If no x's are y's,
And if no z's are y's;
Then some x's are not z's.

109. AT PT I AF
If no x's are y's,
And if some y's are z's;
Then no x's are z's.

110. AT PT I AF
If all x's are y's,
And if no y's are z's;
Then no x's are z's.

111. AT PT I AF
If some x's are not y's,
And if some z's are x's;
Then some z's are not y's.

112. AT PT I AF
If some x's are y's,
And if all z's are x's;
Then some z's are y's.

113. AT PT I AF
If some x's are not y's,
And if no z's are x's;
Then no z's are y's.

114. AT PT I AF
If some x's are y's,
And if some z's are not x's;
Then some z's are not y's.

115. AT PT I AF
If no x's are y's;
And if all z's are x's;
Then some z's are not y's.

116. AT PT I AF
If all x's are y's,
And if some z's are y's;
Then some x's are z's.

117. AT PT I AF
If some x's are y's,
And if all z's are y's;
Then all x's are z's.

118. AT PT I AF
If some x's are not y's,
And if no x's are z's;
Then some y's are z's.

119. AT PT I AF
If all x's are y's,
And if some x's are z's;
Then some y's are z's.

120. AT PT I AF
If some x's are y's,
And if no z's are x's;
Then all z's are y's.

121. AT PT I AF
If all x's are y's,
And if some z's are x's;
Then all z's are y's.

122. AT PT I AF
If some x's are y's,
And if no z's are y's;
Then some x's are z's.

123. AT PT I AF
If some x's are not y's,
And if some z's are x's;
Then all z's are y's.

124. AT PT I AF
If no x's are y's,
And if no z's are x's;
Then some y's are z's.

125. AT PT I AF

If no x's are y's,
And if some x's are z's;
Then some z's are not y's.

126. AT PT I AF

If all x's are y's,
And if all y's are z's;
Then no x's are z's.

127. AT PT I AF

If some x's are y's,
And if no z's are x's;
Then no y's are z's.

128. AT PT I AF

If some x's are not y's,
And if all x's are z's;
Then some z's are not y's.

129. AT PT I AF

If all x's are y's,
Then some y's are x's.

130. AT PT I AF

If no x's are y's,
And if all x's are z's;
Then no y's are z's.

131. AT PT I AF

If some x's are not y's,
And if some z's are not x's;
Then some z's are y's.

132. AT PT I AF

If all x's are y's,
And if some z's are y's;
Then some z's are not x's.

133. AT PT I AF

If some x's are y's,
And if some z's are x's;
Then no y's are z's.

134. AT PT I AF

If all x's are y's,
And if some y's are z's;
Then all x's are z's.

135. AT PT I AF

If no x's are y's,
Then no y's are x's.

136. AT PT I AF

If no x's are y's,
And if some x's are z's;
Then some y's are z's.

137. AT PT I AF

If some x's are not y's,
And if all x's are z's;
Then some z's are not y's.

138. AT PT I AF

If no x's are y's,
And if some y's are not z's;
Then all x's are z's.

139. AT PT I AF

If all x's are y's,
And if all z's are y's;
Then some x's are z's.

140. AT PT I AF

If no x's are y's,
And if some z's are x's;
Then some z's are not y's.

141. AT PT I AF
If some x's are not y's,
And if some x's are not z's;
Then no y's are z's.

142. AT PT I AF
If no x's are y's,
And if some z's are y's;
Then no x's are z's.

143. AT PT I AF
If all x's are y's,
And if no x's are z's;
Then some y's are not z's.

144. AT PT I AF
If some x's are y's,
And if some z's are not y's;
Then some z's are x's.

145. AT PT I AF
If no x's are y's,
And if all y's are z's;
Then some z's are not x's.

146. AT PT I AF
If some x's are y's,
And if some z's are x's;
Then all z's are y's.

147. AT PT I AF
If all x's are y's,
And if all z's are y's;
Then some x's are not z's.

148. AT PT I AF
If some x's are not y's,
And if some z's are not x's;
Then all z's are y's.

149. AT PT I AF
If some x's are y's,
And if no z's are x's;
Then some y's are not z's.

150. AT PT I AF
If no x's are y's,
And if some z's are not y's;
Then some z's are x's.

151. AT PT I AF
If some x's are not y's,
And if all z's are x's;
Then no z's are y's.

152. AT PT I AF
If all x's are y's,
And if all x's are z's;
Then some z's are y's.

153. AT PT I AF
If all x's are y's,
And if some x's are not z's;
Then no y's are z's.

154. AT PT I AF
If some x's are not y's,
And if no y's are z's;
Then all x's are z's.

155. AT PT I AF
If some x's are y's,
And if some z's are y's;
Then some z's are not x's.

156. AT PT I AF
If all x's are y's,
And if some z's are x's;
Then no z's are y's.

157. AT PT I AF
If some x's are not y's,
And if some z's are y's;
Then some x's are z's.

158. AT PT I AF
If no x's are y's,
And if some y's are z's;
Then some z's are not x's.

159. AT PT I AF
If some x's are y's,
And if some z's are not y's;
Then no x's are z's.

160. AT PT I AF
If no x's are y's,
And if no z's are x's;
Then some z's are not y's.

161. AT PT I AF
If no x's are y's,
Then some y's are not x's.

162. AT PT I AF
If all x's are y's,
And if all y's are z's;
Then some x's are z's.

163. AT PT I AF
If no x's are y's,
And if all x's are z's;
Then some y's are z's.

164. AT PT I AF
If some x's are not y's,
And if some z's are x's;
Then no z's are y's.

165. AT PT I AF
If no x's are y's,
And if some z's are not y's;
Then no z's are x's.

166. AT PT I AF
If some x's are y's,
And if no x's are z's;
Then some y's are not z's.

167. AT PT I AF
If all x's are y's,
And if no z's are y's;
Then all z's are x's.

168. AT PT I AF
If no x's are y's,
And if some y's are z's;
Then some x's are not z's.

169. AT PT I AF
If some x's are y's,
And if no z's are y's;
Then some x's are z's.

170. AT PT I AF
If no x's are y's,
And if some x's are z's;
Then all y's are z's.

171. AT PT I AF
If all x's are y's,
And if all z's are x's;
Then some z's are y's.

172. AT PT I AF
If some x's are y's,
And if all z's are x's;
Then some z's are not y's.

173. AT PT I AF — If no x's are y's,
And if all y's are z's;
Then some x's are not z's.

174. AT PT I AF — If some x's are not y's,
And if no z's are x's;
Then some z's are y's.

175. AT PT I AF — If all x's are y's,
And if all y's are z's;
Then some x's are z's.

176. AT PT I AF — If some x's are not y's,
And if no z's are x's;
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177. AT PT I AF — If no x's are y's,
And if no z's are y's;
Then all x's are z's.

178. AT PT I AF — If some z's are not y's,
And if all x's are y's;
Then some z's are not x's.

179. AT PT I AF — If all x's are y's,
Then all y's are x's.

180. AT

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